The
DENTAL JOURNAL
of
AUSTRALIA

Contents

	Page
OCCLUSAL CORRECTION .. .. *C. H. Graham*	181
CHEMICAL STERILISATION WITH SPECIAL REFERENCE TO MUCOUS MEMBRANE AND SKIN .. *M. Jolly, S. E. Wright and H. K. Ward*	192
THE UNERUPTED CUSPID — CO-OPERATION BETWEEN ORTHODONTIST AND ORAL SURGEON .. *F. E. Helmore and R. Y. Norton*	200
SOME CONSIDERATIONS PRIOR TO EXPERIMENTAL FLUORIDATION .. .. *L. M. Carr*	208
THE PATHOLOGY OF THE DENTAL PULP *Frank R. Shroff*	212
THE BUFFER SYSTEMS IN HUMAN SALIVA *B. Lilienthal*	216
DENTAL MATERIALS: CURRENT NOTES No. 23	217
EDITORIAL	218
NEWS AND NOTES	219
ASSOCIATION ACTIVITIES	223
NEW BOOKS AND PUBLICATIONS	
Physiology for Dental Students	224
CLASSIFIED ADVERTISEMENTS	224

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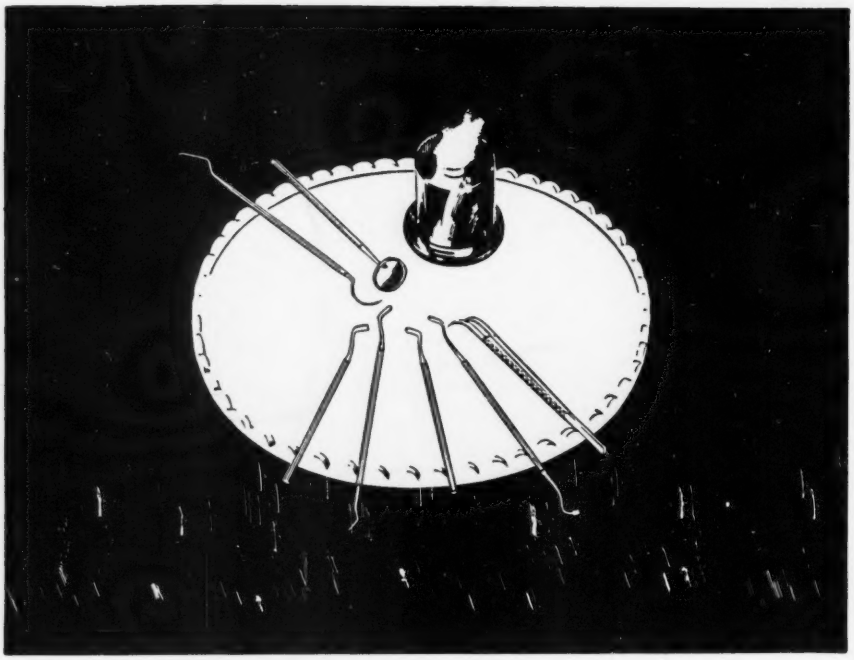

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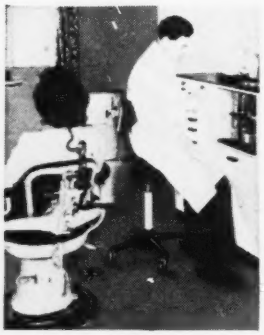

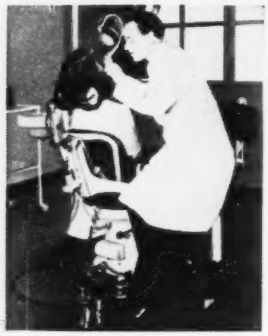

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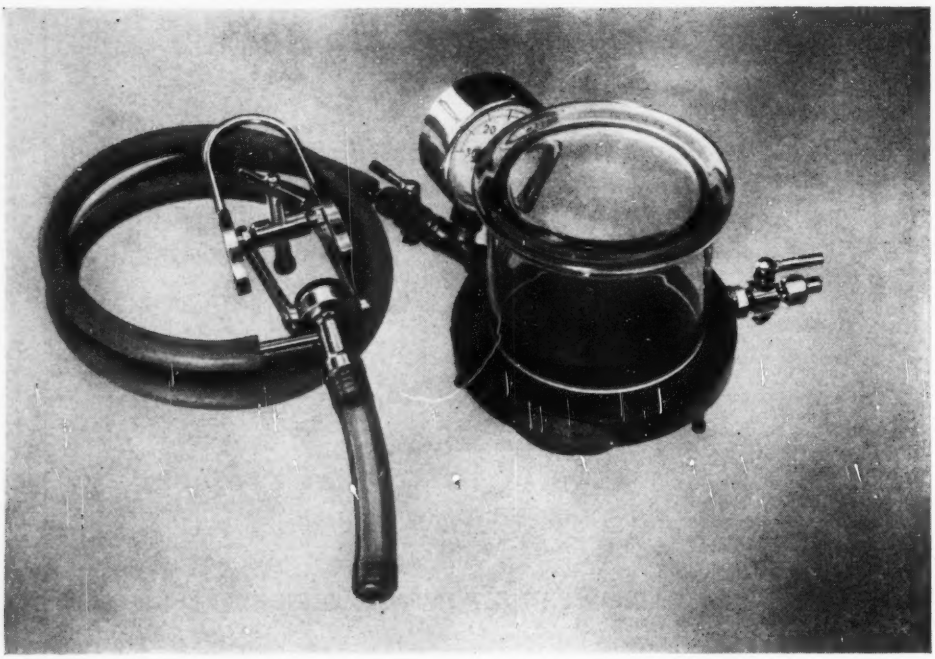

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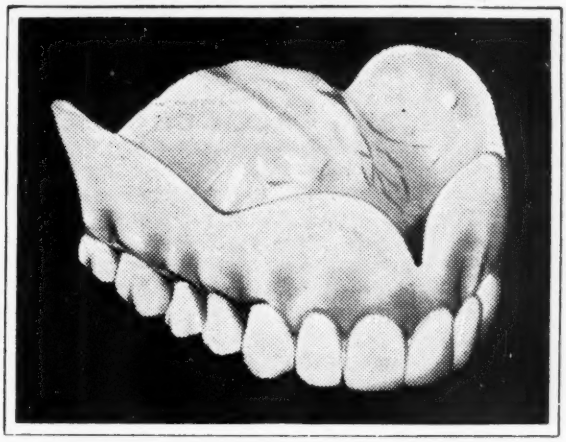

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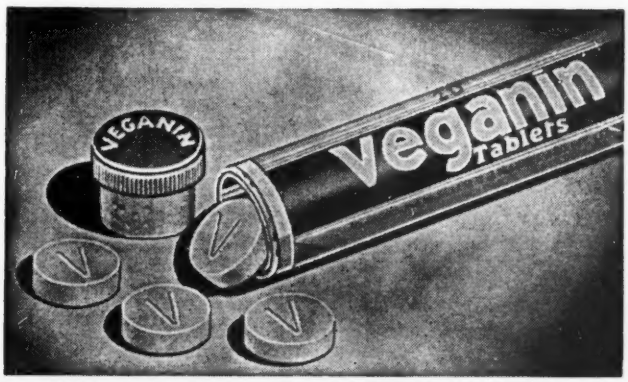

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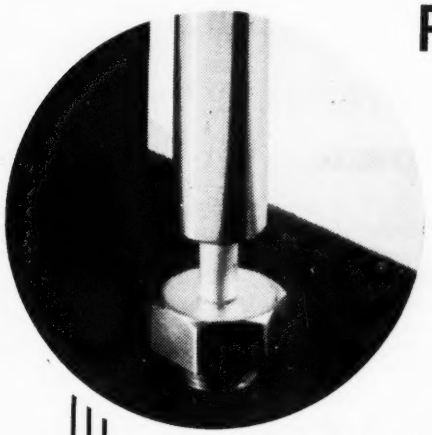

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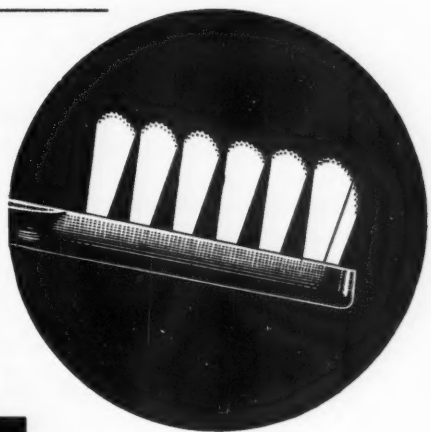

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Occlusal Correction*

C. H. Graham, M.D.S. (Syd.), D.D.S. (N.U.)†

Artificial dentures fulfil a need on the part of the patient for the restoration of natural facial contours and masticatory efficiency.

The methods by which these requirements may be attained are manifold, and though they may differ in the materials employed and in the appliances utilised to produce accuracy of records, they all are designed basically along the same lines: to provide dentures that are within the biological and physiological limits of the patient's oral tissues.

One might even go further and state that, providing an equal meticulousness to detail is observed in each case, many standard techniques will provide dentures capable of a most efficient service.

It must be recognised, however, that no technique has yet been evolved that completely eliminates the dimensional changes of the basic dental materials or can assure that the positional relationships of the mandible can be correctly registered, consistently and accurately, for all types of patients.

In cognisance of these facts and also in the human fallibility of the operator it has to be admitted that in most instances a degree of adjustment is necessary to the occlusal pattern of the processed dentures to assure the desired masticatory efficiency.

Adjustments to occlusion are not however restricted to newly processed dentures. When carrying out periodic inspection to ensure the maintenance of dentures in their optimum efficiency, tests should always be made to assess possible changes to the occlusion occasioned by occlusal wear and bone resorption, irrespective of the age of the dentures.

Assessment of the degree of efficiency of the dentures worn by the patient is an integral part of the diagnosis of denture problems and should be carried out frequently prior to any thought of construction of new dentures. So often it will be found that dentures previously unmanageable may be rendered quite satisfactory by adjustments that provide a balanced occlusion.

This adjustment may be performed at the chairside with a considerable degree of success, by careful reduction of points of cuspal interference until the dentures assume an apparent efficiency of contact and smoothness in function. The procedure relies however upon the patient's intelligence and co-operation to carry out movements according to directions, and upon the operator's skill in interpreting contact markings produced by articulating paper on the occlusal surfaces of the teeth.

A far more preferable method is that of remounting the dentures on an adjustable articulator and as accurately as the articulator will permit adjusting the movements of the articulator to simulate that of the mandible. The occlusion may then be studied carefully with movements under the complete control of the operator, with denture bases remaining fixed to the mountings where all occlusal surfaces are clearly visible, and where compensating movements caused by the resiliency of the underlying soft tissues do not mask occlusal discrepancies.

Remounting Procedures.

The data for remounting the dentures on the articulator comprise a facebow record and a centric record with a protrusive record necessary for condylar adjustments of the articulator.

The facebow or its equivalent.

The correct repositioning of the completed dentures on articulator mountings should be methodically adopted. Although the fact is that some doubt has been expressed as to the value of individual recordings[1], an accurate facebow mounting is of great assistance in duplicating some oral conditions on the articulator. Cuspal inclinations of the posterior teeth can only be correctly interpreted in relation to the registration of the condylar angulation if the dentures are correctly orientated to the horizontal plane. Variations in the occlusal plane both laterally and anteroposteriorly must be faithfully reproduced on the articulator if aesthetic factors have to be considered in the final adjustment.

As a substitute for a facebow record a plaster counter poured into a boxed wax frame positioned in place of the set-up mandibular denture has been suggested. It must be remembered, however, that this method will always produce an inaccuracy proportional to the degree of dimensional change in curing of the maxillary denture.

The ideal method is probably to take a new facebow recording, using softened wax placed on a facebow fork and inserted between the dentures in the mouth. The patient is asked to close until definite impressions of the teeth are recorded in the wax, and the record chilled and removed. The fork may then be held firmly in position by the dentures while the

*Read at the 13th Australian Dental Congress, Brisbane, June, 1953.

†Senior Lecturer in Prosthetic Dentistry, Faculty of Dentistry, University of Sydney.

facebow is assembled. The whole procedure should not occupy more than a few minutes.

Another repositioning method recommended is provided by the grooving of the models prior to initial mounting or the use of split mounting plates. The models may then be removed carefully from the mountings prior to processing, the bases being veneered with thin foil and repositioned following deflasking. This "split cast" mounting technique, as the above procedure is called, permits the possibility of correction of the occlusion immediately following deflasking. Occlusal disharmony caused by warpage during processing is eliminated as the processed dentures are not removed from the casts on which they were cured until occlusal correction has been made.

The original centric relationship of the models is preserved by the mounting plaster to enable the adjustment to the occlusal surfaces to be carried out before the final polishing of the dentures.

If the cured dentures have been removed from their appropriate casts, they must be remounted on the articulator with fresh plaster (after obliterating objectionable undercuts on the tissue side of the dentures with wax or other plastic material) using new facebow, centric and protrusive records. If any attempt is made to remove the dentures from the models before the adjustments, in most cases the models are so mutilated as to provide little stability for the dentures on the articulator, and it will be found that with the release of internal strains the denture bases will not fit the original models intimately.

The procedure is also considered ideal for the saving of chairside time and for the fact that, following the final polishing, the dentures may be inserted and require only minor adjustments for contours and extension of flanges.

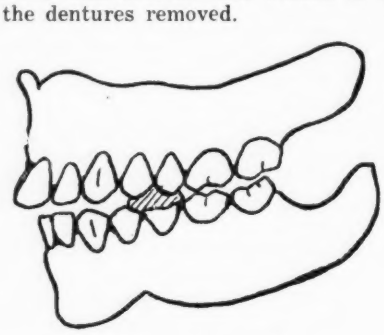
Should there be an error in the maxillo-mandibular relationship, an occurrence that is always a distinct possibility, a new centric record must be taken and the lower denture remounted. With this repositioning of the mandibular denture further occlusal adjustment will then be necessary. The adjustment, following that carried out prior to the clinical insertion appointment, may be sufficient to seriously obliterate the occlusal anatomy of the teeth, and, irrespective of care taken during the procedure, must limit the ultimate efficiency of the dentures.

The rule should be adopted that, wherever there is a doubt as to the accuracy of the maxillo-mandibular relationship, all grinding of the artificial teeth should be avoided until the insertion of the dentures. It is preferable initially to spend adequate time at the setting up stage of the denture, to select posterior teeth of the most satisfactory cuspal inclination and then carefully arrange them so as to avoid mutilation of the cusps by excessive grinding subsequently.

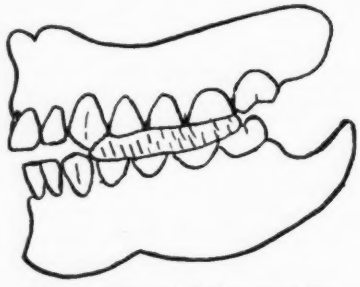
The centric record.

The most suitable record obtainable in instances of occlusal discrepancy is one in which the premature contact between dentures is not permitted to operate as such. Careful observation in the mouth will determine the region of the premature contact.

A small strip of wax is softened and placed on the mandibular denture on the bicuspid and first molar teeth, distributed as equally as possible on each side both in area covered and thickness of softened wax. The denture is immediately placed in the mouth, relaxation of the muscles of mastication obtained and then the jaws occluded until the teeth almost penetrate the wax record. The record is chilled and the dentures removed.



(a) Wax stop in position.



(b) Wax stop and plaster recording.

Fig. 1.—Wax and plaster combination for centric recording. The thickness of the wax stop must be sufficient to prevent premature tooth contact.

The dentures are then related in the hand, using the centric record, and examined for stability on the record and freedom from actual cusp contact. If there is any penetration of the wax by opposing cusps, the record is discarded. If these requirements are satisfied, the dentures are then sealed together at points away from the record, mounted on the articulator and the mandibular denture attached with plaster.

Where the area of the centric recording is restricted by the premature contacts so as to produce an inaccurate re-assembly, the centric record is restricted to the second lower bicuspid on each side. Registration on the wax is carried out as previously described and then after chilling the wax quick setting plaster is flowed between the dentures while the patient maintains light contact on the wax record. This method will produce an accurate record with stability provided prior to the initial set of the plaster by the wax stop. Re-assembly of the models is facilitated by the detailed impressions in plaster of the opposing cusps. (Fig. 1).

The protrusive record.

The protrusive record is required for the adjustment of the condylar slots of the adjustable articulator. Though this recording has been criticised[2], consistency in the details of the procedure will produce gratifying results. Certain requirements for the record must be carefully observed:—

(i) The layer of baseplate wax must be carefully heated to acquire an even consistency and maximum plasticity, then folded and placed on the whole of the occlusal surface of the mandibular denture.

The thickness of the wax layer is dependent on the results of examination of the protrusive contacts of the denture in the mouth. If it is observed that a space exists posteriorly when the patient assumes edge-to-edge anterior contact, the wax is increased in height posteriorly when loading. Where posterior contact only is present the softened wax is increased in thickness anteriorly.

(ii) The wax and denture should be placed as soon as possible in the mouth and the recording completed.

(iii) The wax record when chilled must be of sufficient hardness to avoid deformation during articulator adjustment.

(iv) The recording must be carried out without pressure.

(v) Should there be any penetration of the softened wax to give tooth contact, the recording must be discarded.

(vi) The extent of forward movement must be in the region of ¼" unless further movement is necessary to similate an edge-to-edge incisor position. A protrusion of less than ¼" will proportionately decrease the accuracy of adjustment of the condylar slot.

(vii) The record must be carefully prepared by cutting away the wax buccally and labially to the apices of the incisal edges and the buccal cusps.

Occlusal Contacts.

The purpose of adjusting the occlusion of the dentures is to provide sufficient distribution of contacts between the dentures for an efficiency of mastication and a distribution of the contacts for stabilisation of the dentures during the masticatory movements. The occlusal contacts may be divided into centric and eccentric contacts.

Centric contact distribution.

The primary need for centric contact is that of providing a stability of the dentures by even distribution of the occlusal load on closure for the preservation of the underlying alveolar bone, both laterally as well as an anteroposteriorly. It becomes increasingly important as the quality of the supporting structures decreases.

In a normal ridge relationship the centric contacts should extend from the mandibular first bicuspids to the first molar equally on each side.

With retruded mandibular jaw relationships the balance of contacts is far more difficult to obtain and, unless care has been observed in the setting-up stage, the possible contacts may be restricted only to the posterior teeth of both dentures. On the other hand, with prognathic mandibular relationship, if incisor contact is present in centric relation, it may be necessary to provide contacts on the 2nd molars to balance the incisor contacts.

Eccentric contact distribution.

The ideal distribution for protrusive contacts should provide maximum effectiveness of incision over all the incisors, especially in regard to the cuspid contact. In conjunction with this anterior contact at least one contact in the molar region on each side must be present. For maximum stability there should be complete bilateral contact of the posterior teeth for all degrees of protrusion from an edge-to-edge incisal contact back to centric occlusion.

Lateral contact distribution.

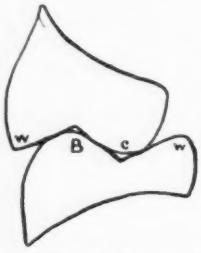
The contacts during a lateral movement will consist of a combination of a working side range and at least one balancing side contact during any position between the centric and eccentric position.

The working side range of contacts should be as extensive as possible. It has been clearly shown that the masticatory efficiency depends to a great extent on the presence of these contacts.

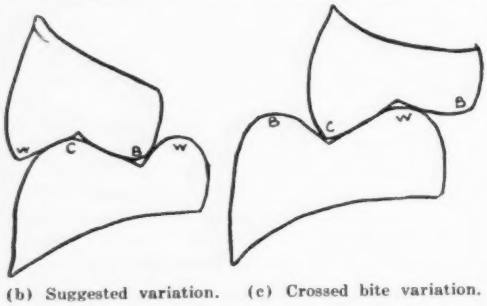
Due to the translatory movement taking place in the eccentric movement the balancing side contacts cannot be ignored, though they do not need to be as extensive as on the working side; if they do not exist, the efficiency of the working side is greatly impaired.

Cusp Function.

Having in mind the above requirements for satisfactory distribution of contacts, examination of the mounted dentures will soon disclose their inadequacies. It is obvious that if the distribution of contacts between dentures is not considered sufficient for stability or efficiency, progressive removal of these contacts by grinding will increase the areas of contact until their distribution is satisfactory. Reduction by haphazard grinding may produce satisfactory results in one eccentric occlusal position without any guarantee that the condition will be improved or even maintained for other occlusal positions. Reduction by milling with carborundum paste has been shown to do little to improve the condition.



(a) According to Schulyer[3], Swenson[4], and Boucher[5].



(b) Suggested variation. (c) Crossed bite variation.

Fig. 2.—The cusps may be given specific duties for contact in centric and eccentric positions, W represents that reduction permissible if interfering in working position, B in balancing position and C in centric position.

Schuyler[3] and Swenson[4], have shown that it is possible to allot specific duties to individual cusps and sulci, and have described a sound procedure for the adjustment of discrepancies with optimum preservation of balance and tooth structure, so aptly called a selective grinding procedure.

Acording to their plan of treatment the centric equilibrium is maintained by the maxillary lingual cusp in contact with the mesiodistal groove of the opposing tooth. The rule is adopted that interference presented by this contact is not adjusted by reduction of the lingual cusp if the cusp is required to maintain contacts in eccentric positions, but rather by increasing the depth of the mesiodistal groove of the lower tooth. Should, however, the cusp be causing interference in both eccentric positions, it is reduced.

Desirable contacts on the working side consist of contacts between the maxillary and mandibular buccal cusps, maxillary and mandibular lingual cusps. Premature contact between either of these groups of cusps is readily corrected by reduction in the heights of the buccal cusps of maxillary teeth and the lingual cusps of the mandibular teeth, without affecting contacts for centric occlusion.

The contact available on the balancing side is between the maxillary lingual cusp and the mandibular buccal cusp. Interference produced by these contacts may be adjusted by reduction in the height of the mandibular buccal cusp.

This preservation of the cusps for contacts in specific jaw positions is recognised as the soundest method available to eliminate interferences and produce a balanced occlusion. Schuyler has stated that selection of the maxillary lingual cusp is most desirable for maintaining centric occlusion as cuspal contact tends to produce the maximum stability of the mandibular denture.

It has been observed that in the reduction of marked discrepancies the mandibular buccal cusp becomes flattened to an extent as to be inefficient as a cutting blade; therefore it might prove more satisfactory to adopt a procedure whereby the centric contact is provided by the mandibular buccal cusp resting in the mesiodistal sulcus of the maxillary tooth. (Fig. 2.)

Selection should be made of mandibular posterior teeth with a sharp well defined buccal cusp, that should be maintained throughout the procedure of selective grinding as close as possible in its original condition. To permit this, a change in procedure must be made in considering the reduction of premature balancing contacts; instead of the mandibular buccal cusp, the maxillary lingual cusp is reduced.

A further requirement will be the careful placement of the mandibular buccal cusps originally in the setting up, no further buccally than above the crest of the mandibular ridge.

Crossed bites.

Where a partial crossed bite has by necessity been incorporated into the tooth arrangement, the maintenance of centric occlusion is essential by the contact of the maxillary buccal cusps in the mesiodistal grooves of the man-

dibular teeth. Reduction of discrepancies on the working movement must be at the expense of the mandibular lingual cusp. Adjustments for balancing movements must be restricted to mandibular buccal and maxillary lingual cusps.

It will be found that the standard moulds of posterior teeth do not lend themselves to crossed bite relationships and must be recontoured at the setting up stage for best results by reduction in the height of the mandibular buccal cusps. As the area of function for the working movement is so restricted it is essential that the maximum efficiency of cuspal contacts be provided.

Selective grinding will produce a smooth articulation provided the discrepancies are of a minor degree, but should the normal interdigitation of the teeth be disturbed the method of attack is not always obvious. Careful examination must be made in each instance to decide whether the discrepancy warrants reduction by grinding or remaking of one or both of the dentures.

Vertical discrepancies.

The vertical discrepancies possible will vary from an outright excess of vertical dimension throughout the whole occlusion to either an anterior or posterior premature contact.

Overall vertical increase.

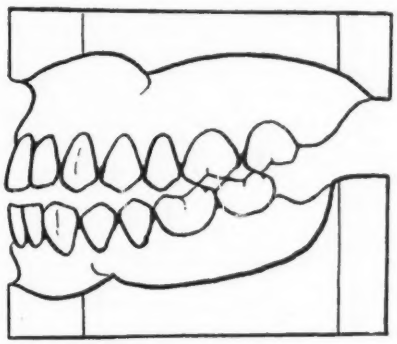
In this condition the treatment will depend on the degree of discrepancy. The amount of reduction required must be determined clinically in relation to the degree of possible modification of occlusal surfaces. Where the condition is considered within the limits of grinding, all cusps involved must be reduced and mesio-distal grooves deepened until the required vertical dimension is achieved. Wherever there is a doubt as to an ultimate reasonable cuspal form with efficiency of cutting edges, it is always preferable to reset the teeth of at least one of the dentures.

When the error is extensive it may be attributed to previous clinical error which can only be remedied by removing the teeth from the mandibular denture to permit a fresh denture record at the required vertical dimension, so that the teeth may be reset and the denture reprocessed.

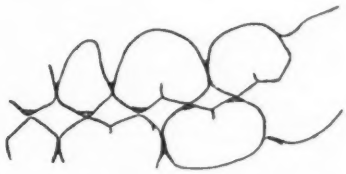
Vertical dimension increase due to posterior premature contact. (*Fig.* 3.)

The problem that confronts the operator is the determination as to whether the vertical increase is due to tooth movement during processing of the maxillary, or mandibular, or of both dentures. If a split cast method of mounting is employed, this can be generally avoided, the maxillary denture being cured and replaced on the articulator immediately following deflasking to be checked against the opposing waxed set-up. Discrepancies will be immediately obvious and may be readily adjusted either on the cured denture or the waxed set-up before completion of curing.

If the split cast method has not been used and if the mandibular bite rim incorporating the occlusal plane to which the maxillary teeth were arranged is still available, variation of tooth position of the maxillary posteriors may be readily checked by removing the mandibular denture and substituting the bite rim on the articulator mounting. Any change in the compensating curve originally developed on the denture during setting up will be obvious. These bite rims should always be preserved until the completion of the case for they will often be a means of shortening subsequent clinical corrective procedures.



(a) Posterior premature contact.



(b) Corrective procedure.

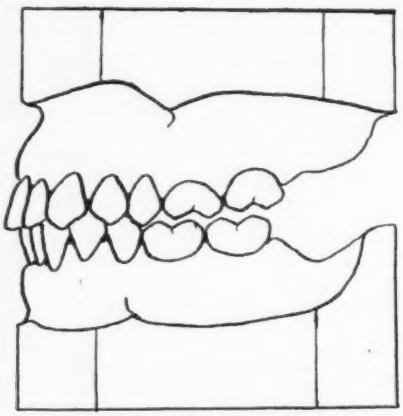
Fig. 3.—With posterior premature contact alteration of the maxillary cusps will produce a steeper compensating curve whereas reduction of the mandibular cusps may have the effect of a reduced curve.

Where bite rims are not available, a check on the posterior maxillary tooth position may be made by removing the mandibular denture from the articulator and setting in wax mandibular molars in centric relation with the maxillary denture. A test movement is made for protrusion. If balance is not maintained adjustment to the maxillary posterior teeth will be necessary, in such a way as to re-establish the necessary compensating curves. The remedy lies in reduction of both cusps and sulci of the tooth or teeth concerned until centric occlusion is re-established.

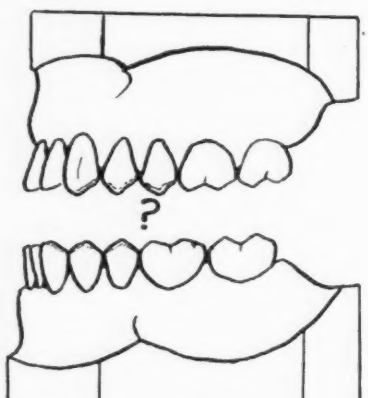
Anterior vertical increase. (*Fig.* 4.)

In this condition the discrepancy will be caused by bicuspid movement if originally incisal contact was not incorporated in the centric tooth arrangement. Variation in the occlusal plane in this region will decide the area of reduction necessary.

Anterior vertical increase by premature contact of the incisors where the incisors are primarily arranged edge to edge may be adjusted with consideration to the aesthetic requirements.



(a) Anterior premature contact.



(b) & (c) Corrective procedure.

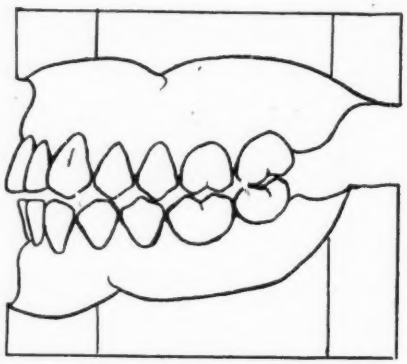
Fig. 4.—With anterior premature contact reduction of the maxillary or mandibular bicuspid cusps will alter the compensating curves of either arch.

CENTRIC DISCREPANCIES.

Centric discrepancies will not be evident in many instances by the scrutiny of the completed dentures in the mouth; therefore it should be a standard procedure that all cases be remounted with appropriate records irrespective of whether the occlusion appears satisfactory or not.

For accuracy of centric recording care must be exercised to prevent contact between porcelain tooth inclines; such inclines will inevitably have a shunting effect tending to reproduce the previous error.

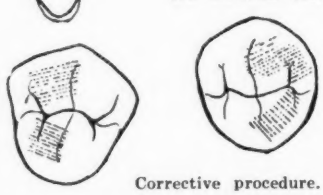
On studying the remounted cases, the decision must be reached as to whether the discrepancy can be adjusted by grinding procedures without impairing masticatory efficiency or whether it would be preferable to reset the mandibular teeth.



(a) Retrusion producing premature contacts.

(b) Buccal view.

(c) Occlusal view.



Corrective procedure.

Fig. 5.—With distal mandibular relationship the reshaping of the distal inclines of the mandibular cusps must be carried out with every effort to preserve the general anatomy of the teeth, by even reduction over the whole of the inclines.

Experience will readily determine treatment necessary but, failing that, definite rules may be expounded as a basis of approach to the problem according to the type of error.

Centric discrepancies will consist of two types:—

1. A more retruded position of the mandible in its entirety, or
2. A lateral swing produced by a retrusion of one condylar head.

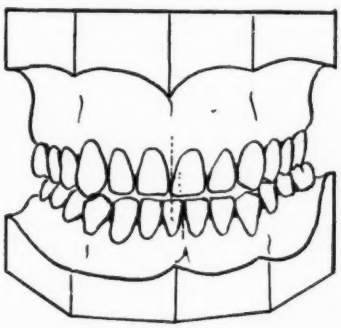
(1) *Complete retrusion.* (*Fig.* 5.)

Slight movement distally of the mandibular denture may be accommodated by reduction of the distal slope of the mandibular buccal and lingual cusps, with some reduction necessary to the mesial slopes of the maxillary buccal and lingual cusps to facilitate adequate working side movement. It has been found that the greater the distal movement to be corrected, the greater is the decrease in efficiency of the working movement.

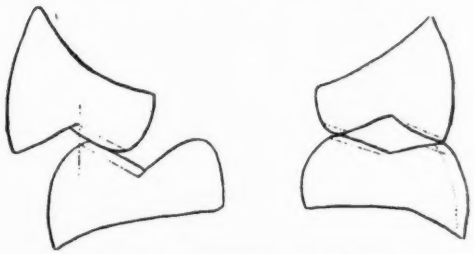
Should the distal movement approach half the mesio-distal width of the bicuspid teeth, then grinding procedures are not recommended. Corrective procedures in this instance would tend to obliterate the cusp height of the posterior teeth with resultant inefficiency in function. In these cases it is far preferable to reset the offending mandibular teeth by a remodelling or a repair process.

(2) *Lateral swing.* (*Fig.* 6.)

The deviation of the mandibular denture to one side will not only reduce the efficiency of the dentures but will also remove the protective mechanism of overjet from the posterior teeth on one side to expose the patient to the traumatic effects of cheek biting. One side will tend towards the working relationship of cuspal contacts and the other to the balancing contact tendency.



(a) Lateral shift producing premature contact.



(b) and (c) Corrective procedure.

Fig. 6.—This diagram illustrates the scope of reduction necessary to effect a degree of efficiency in correcting a lateral shift. Unless carefully effected gross mutilation of occlusal anatomy is inevitable.

Where relationship tends to a working mandibular movement some degree of efficiency may be imparted by reduction in the height of the maxillary buccal cusp and the lingual mandibular cusp.[5]

In conjunction with the above it may be necessary to reduce the prominences of the buccal surface of the mandibular teeth by discing to restore an adequate overjet of the maxillary buccal cusps.

Where the relationship tends to a balancing mandibular movement, restoration of centric contacts may be obtained by reduction in height of the maxillary lingual cusp.

Where the lateral shift is sufficient to provide a contact of lower buccal cusps below the maxillary buccal cusps the condition should be considered as ungrindable; resetting of the mandibular must be adopted.

PROTRUSIVE DISCREPANCIES.

Protrusive discrepancies will depend on how far the cases fail in the protrusive requirements as already expounded, and may be treated accordingly.

Incisal protrusive contact without posterior bilateral balance. There are two possibilities as to the cause of this error:—

(i) Incisal tooth movement or (ii) inaccuracy of the previous protrusive record.

(i) This will be obvious by the fact the wax protrusive record confirms that a satisfactory condylar articulator inclination was employed to arrange the teeth in the first instance.

Correction of the discrepancy will be mainly on an aesthetic basis.

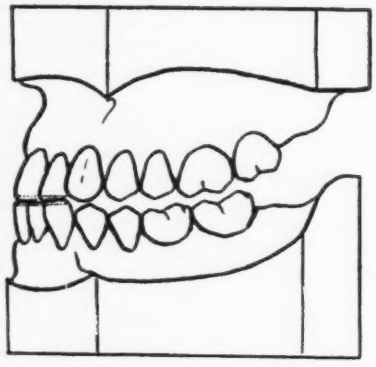
If the maxillary incisors appear too prominent they may be reduced to satisfy the aesthetics of the case. If further reduction is necessary the mandibular incisors may then be reduced.

The reduction in both instances should be at an angle to the long axis of the teeth in keeping with the relationship between angulations of the posterior teeth and the condylar movement. (Fig. 7.)

(ii) The rechecking of the protrusive slope may show that the condylar slot angulation used in the arrangement of the teeth was smaller than necessary, leading to the construction of dentures with an inadequate compensating curve.

Such an error may occur by penetration of the original protrusive record anteriorly by pressure at the recording stage. It may also occur by anterior premature contact and pres-

sure elevating the dentures posteriorly away from their tissue contact. The remedy lies in reproducing a more satisfactory compensating curve in the dentures. If the discrepancy is slight the adjustment may be carried out by selective grinding. If severe, resetting of the posterior teeth on both dentures will be necessary, unless it is possible to increase the compensating curve of the maxillary denture by judicious grinding and then reset the mandibular posterior teeth in a repair process.



(a) Anterior premature contact.

(b) Corrective procedure.

Fig. 7.—Where the anterior teeth contact without adequate posterior contact, aesthetic effect will determine the choice for reduction. The teeth should be ground with incisal angulations in keeping with the general cuspal pattern.

Adjustment by grinding.

The compensating curve on the maxillary denture can only be increased by an accompanying decrease in the vertical dimension of the case. The vertical dimension decrease is brought about by:—

(a) Deepening the mesiodistal grooves of the maxillary and mandibular molars.

(b) Reduction of the buccal and lingual inclines of the occlusal surfaces of the 2nd maxillary molar, and

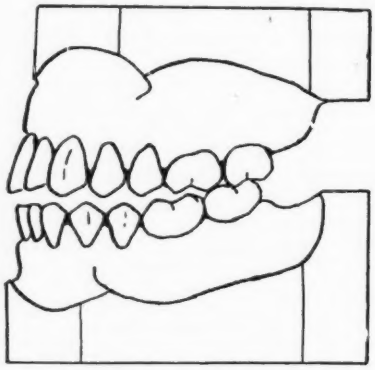
(c) Reduction of the height of the buccal cusps of the mandibular bicuspids.

(d) Raising the occlusal plane level of the maxillary incisors by incisal grinding.

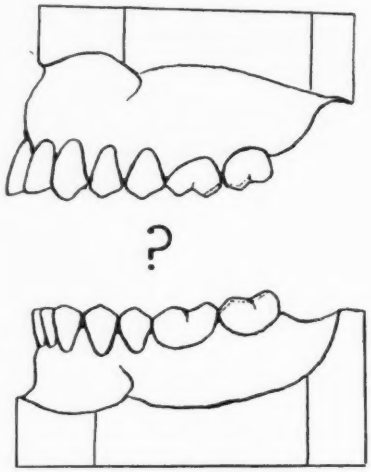
This new cuspal rearrangement will bring out an increase in the prominence of the compensating curve. Following the establishment of the centric occlusion selective grinding is necessary to finalise the inclines for lateral movements.

Posterior protrusive contact without incisal contact. This discrepancy will be produced by an original protrusive record inaccuracy in that too steep a condylar slot angulation of the articulator was employed at the setting up stage. The error may be readily produced by excessive pressure generated on the distal section of the recording area of the protrusive record or incisal tilting of the bite rims during the bite recording.

The remedy lies in the reduction of the prominence of the compensating curves of both dentures. If the discrepancy is large it is preferable to reset the teeth of both dentures



(a) Posterior premature contact.



(b) Corrective procedure.

Fig. 8.—The shaded cusp apices represent possible reduction areas, leaving adequate inclines for lateral movement function.

utilising a lesser prominence of curve for the posterior teeth. Where the discrepancy is slight, adjustment by grinding is possible. The apices of the buccal cusps of the maxillary bicuspids and first molars are flattened with minimum interference to the guiding inclines of these cusps. (Fig. 8.)

The apices of the buccal cusps of the mandibular second molar are flattened removing it from centric contact. These two operations will produce a flatter curve for the posterior teeth, without alteration to the vertical dimension of the dentures.

Partial Dentures.

In the correction of occlusal discrepancies in partial dentures the principles already laid down for the selective grinding of cusps and sulci still hold. The procedure must however be modified according to the types of restorations employed. With complete dentures it is possible to adjust the vertical dimension changes in the protrusive and lateral movements to produce optimum balance. Where cusps of natural teeth are included in the procedure they must dictate the movements with the artificial cuspal contacts adjusted to the articulation of the natural teeth.

For this reason it is always preferable to study the mandibular movements on the articulator prior to any serious design of the partial denture. So often it will be found that lateral and protrusive excursions can be greatly improved by some slight occlusal adjustment to the natural teeth. (Figs. 9 and 10.)

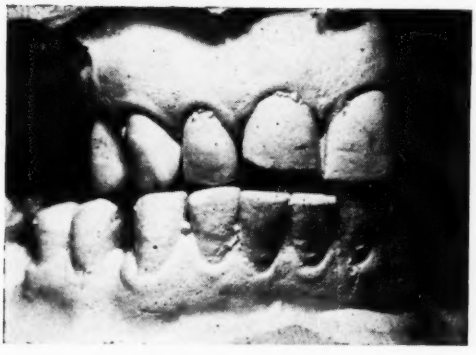


Fig. 9.—Working movement contacts which could be rendered more extensive and efficient by judicial grinding.

In conjunction with the designing of the dentures, occlusal rests may be recessed into the enamel and embrasures prepared for retainers to avoid any increase in the vertical dimension by sections of the retaining devices, *and only after this preparation are the final impressions recorded.*

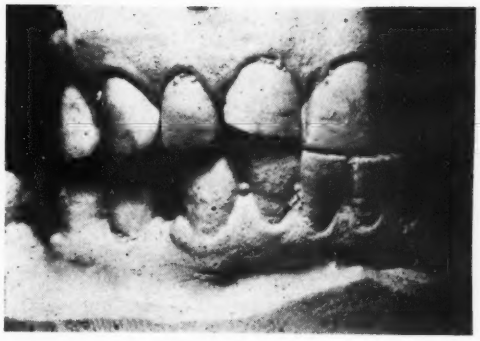


Fig. 10.—Central incisor contact in eccentric position which should be investigated to ensure adequate protection from overloading.

It will be found that the distribution of contacts is far more restricted for eccentric positions in partial dentures to those available in complete denture prosthesis. This occurs as a result of the natural curvature of the Curve of Spee which may produce only unilateral balance in a lateral movement and no posterior balance in protrusive positions. (Figs. 11 and 12.)

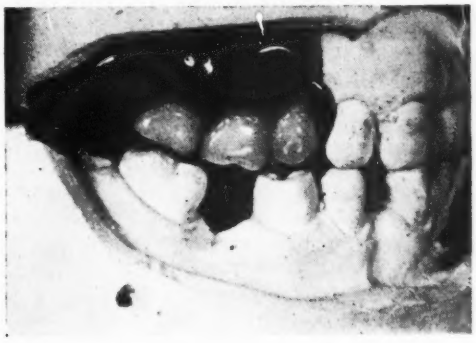


Fig. 11.—A tissue-borne saddle in centric occlusion.

Several other facts must be kept in mind in considering the problem:—

1. The patient is capable of exerting a considerably greater occlusal force with natural teeth present than when functioning with complete dentures.
2. The partial dentures are rigidly secured to the abutment teeth. As tilting of the dentures is restricted by the design the occlusal force is mainly directed to specific abutment teeth. With premature contact the whole occlusal force is directed to the artificial base, which will either ultimately fracture or continue to transmit the load to the abutments. If the load is beyond the physiological limits possible for the teeth concerned, degenerative changes in the supporting structures must take place.

Where the excessive load is transmitted to the tissues by a tissue-bearing saddle, resorption will be stimulated until the interference no longer operates.

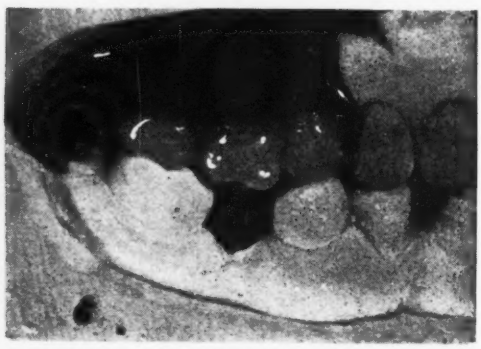


Fig. 12.—The same tissue-borne saddle in protrusion unable to maintain occlusal contact.

ADJUSTMENT PROCEDURES.

(1) *Intra-orally.*

Restoration of the masticatory function is facilitated by the presence of the natural teeth. Previous study of the occlusion without the denture will have determined the natural cuspal contacts in centric and eccentric positions. Observations with the denture in position will readily determine points of interference and the degree of vertical opening evident by the degree of lack of contact between the natural tooth inclines, which were previously known to maintain contact.

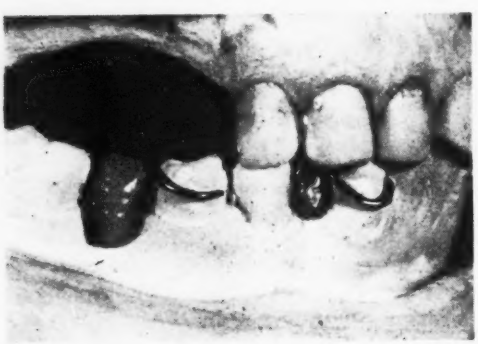


Fig. 13.—Mandibular partial denture adjusted for occlusal contact on the anterior saddle only.

Where an artificial tooth is forming a premature contact with a natural tooth surface it is customary to reduce the artificial surface. Where the premature contact exists between two artificial surfaces, the reduction is along the lines of the selective grinding procedure.

As a standard procedure where both a maxillary and mandibular partial denture are to be inserted, adjustments are carried out with one denture at a time against the opposing natural occlusion. Both dentures are then inserted and opposing artifical tooth surfaces selectively ground in until the function of the natural tooth inclines is fully restored. (Figs. 13-15.)

(2) *Extra-orally.*

Where large partial restorations are to be adjusted the use of the articulator will facilitate the procedure. Providing the dentures have been processed on duplicate models it will be possible to fit the finished dentures on to the original models. These models may be mounted on the articulator by a remounting record and the original bite record which has been preserved for the purpose, or a new recording.

It will be possible to spot grind interferences utilising the principles of selective grinding, providing care is observed not to mutilate the plaster replicas of the natural teeth.

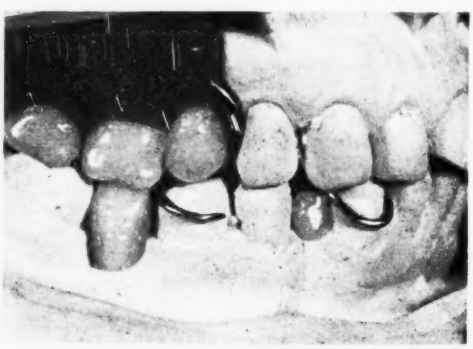


Fig. 14.—The maxillary denture is adjusted separately for contacts on natural opposing occlusion. Then both dentures inserted together permit the final adjustment of artificial to artificial tooth contacts.

An alternative procedure useful for dentures involving large tissue-bearing saddles may be employed. Protrusive and centric re-

Fig. 15.—The opposing tissue-borne saddles permit the full scope of adjustment by selective grinding.

cords are obtained with the dentures in position. Impressions are taken with an alginate impression material of the natural teeth and the denture in position, which will be removed with the impression. Models are then prepared, and mounted on the articulator with the centric record, the condylar slots being adjusted with the protrusive record. The occlusion may now be readily studied and a planned treatment carried out.

Milling Procedures.

As a final refinement of the occlusion milling with fine carborundum paste and glycerine may be employed. The milling should be only sufficient to produce smooth movement from eccentric to centric occlusion and should not exceed thirty strokes in each direction.

Manipulation beyond these limits seriously increases the possibility of reduction of the vertical dimension, reduces the efficiency of the cuspal cutting edges and lessens the efficiency of balanced contacts. The grinding paste is then flushed away and the manipulation continued, making sure that the movements are restricted only to those from eccentric positions back to centric occlusion to avoid shearing of labial and buccal porcelain surfaces. This procedure will polish the surfaces reduced by the milling procedure.

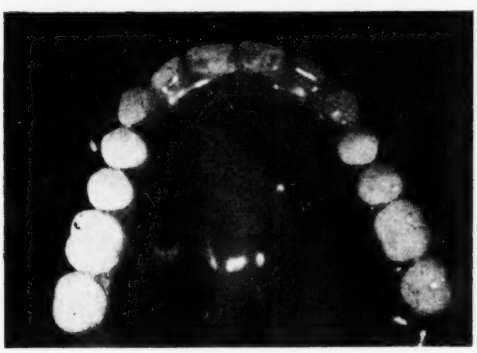


Fig. 16.—An example of gross occlusal reduction with almost complete obliteration of the occlusal anatomy.

Tooth Anatomy Reconstruction.

Where corrective procedures have obliterated tooth anatomy a degree of efficiency may be restored by judicial use of fine mounted stones. The carving may be of an anatomical or mechanical nature. Whatever the choice every care must be observed in maintaining the centric contacts. As a precaution it is advisable to mark the centric contacts with articulating paper prior to this operation. Cusp apices may be sharpened provided a vestige of the guiding inclines is preserved, for eccentric movement. **(Figs. 16 and 17.)**

Instrumentarium.

Articulating paper. Fine articulating paper is to be preferred. Blue articulating paper may be used for lateral and protrusive movements and red marking paper for centric occlusion.

Mounted stones.

The fine knife edged stones are the most satisfactory for shaping cuspal inclines and as they wear down may be used for marginal ridge reduction. The small ½" diameter wheel

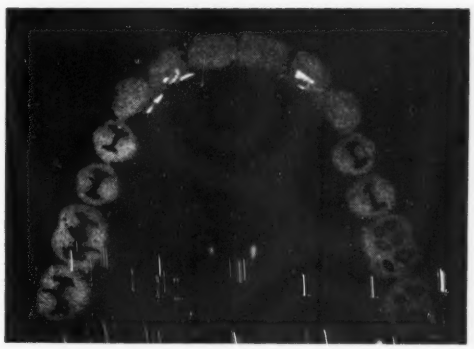


Fig. 17.—The mechanical restoration of guiding inclines and sluiceways by preparation of circular recesses with fine round stones on the molars to the right side of the diagram in comparison to the left side where restoration of anatomy is prepared with fine edged stones producing sharp sulci of an anatomical pattern.

stone is satisfactory for incisal reduction. The cone shaped stones are satisfactory for deepening the mesio-distal groove and reshaping the cuspal anatomy.

Summary.

1. Completed dentures should be remounted on a suitable articulator and carefully studied.
2. Where the correction of discrepancies in balanced occlusion is considered to be within grindable limits every effort should be made to maintain occlusal anatomy and efficiency.
3. Where doubt exists as to the success of occlusal grinding, resetting of teeth is to be preferred.

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Chemical Sterilisation with Special Reference to Mucous Membrane and Skin*

M. Jolly, S. E. Wright and H. K. Ward.

The Chairman:

Our topic of course is one which is always of interest to the surgeon, dental or other, and, although it is many years since Lister's epoch-making discovery and its application to surgery, concerning skin and mucous membrane, we are still in that antiseptic age, as it were. New substances are being brought out every year but we are a long way from having what one might call the perfect chemical disinfectant. Of course the word "perfect" must be defined in relation to the particular object in view. What would be the perfect specimen for, say, a metal instrument would certainly not of necessity be the perfect one for the skin or mucous membrane.

It is not difficult to enumerate a few quite general attributes which chemical disinfectants should have. In the first place, if we intend to use them on skin or mucous membrane, they must not be irritant or cause other and more serious damage. They ought to act quickly and they must be reasonably stable. They are substances we like to store round the operating theatre and elsewhere and to take the bottle down and use, just as we see the need. Also, because we are going to use many of them in relation to living tissues, obviously they must not be affected deleteriously by the body fluids. Moreover, they have to be effective against all kinds of organisms, because in such areas as the mouth we never know quite what organisms we are going to meet; we have a general idea, but all kinds of adventitious additions to the flora are made from time to time.

We propose this evening to proceed along what we think is a reasonable line. First of all the clinical problem will be presented; then the scientific background will be discussed and, in this particular case, that will be followed by reference to some of the more specific bacteriological problems involved. So, without more ado, I shall ask Mr. Jolly to discuss with us the clinical problems, the requirements which the clinician has in mind when choosing a suitable chemical disinfectant.

Mr. Jolly: I feel that my task is a very simple one, merely to pose the questions which we hope will be answered by Mr. Wright and during the discussion afterwards. It is almost a century now since carbolic acid was used to disinfect instruments, dressings and even human tissues. Today we look for chemical sterilising agents which will not only bring about destruction of bacteria, but which are bland and not harmful to the tissues. Now, I have grouped my remarks in three categories, and the first one concerns a general survey of the application of chemical sterilisation.

1. While chemical sterilisation is very convenient, offering ease of application and requiring only very simple equipment, there are always some doubts as to its effectiveness. This suggests that the first question that we might ask is "Just how effective are these sterilising agents, what are their limitations, when can we use them, and when must we lay them aside and turn to the very sure method of using moist heat?" Another factor which I think is of great interest to us, as dentists, is the mode of action in achieving sterilisation, i.e. the actual chemical reactions which take place when these agents destroy bacteria.

The next question is "What concentrations of these chemical agents do we need?" Coupled with that we might think about the time factor. Time is a factor with all types of sterilising, whether we are using heat, moist or dry, or any other method, and all too often we, as dentists, must rely upon the literature put out by manufacturers of the various chemical agents. Physical properties of the sterilising agent also play a big part — properties such as surface-tension and viscosity. Lastly, I think it desirable that we should have some information on tissue-tolerance, including the regenerative power of tissues once subjected to certain sterilising agents.

2. In the second section of my remarks I shall discuss the skin and mucous membrane, which are the main topics on which Mr. Wright is to speak. Before attempting oral surgery, we prepare a certain area of skin around the oral cavity; after that the rest of the tissues are draped off and we can then proceed to "sterilise" or prepare the field within the oral cavity. Again, certain types of oral surgery require an extra-oral approach, and so we have to think not only of surface bacteria, but also of bacteria which may reside within and beneath the surface of the skin. Our knowledge of this subject is very limited, particularly of those organisms which reside within the sweat glands. In preparing the

*A record of the Proceedings of the Discussion Group of the Institute of Dental Research, United Dental Hospital, Sydney, 13th July, 1953. (Chairman: N. E. Goldsworthy).

tissues of the oral cavity for surgery, we have further problems inasmuch as the mucous membrane itself is much more delicate than the surface epithelium of the skin. An added difficulty is caused by the physical configuration of the oral mucosa: the gingival crevices and the papillae of the tongue make it more difficult to prepare the mucosa and there is of course a rich and varied flora within the mouth. A further problem is the protecting influence of saliva within the oral cavity: not only may the saliva protect the underlying bacteria from the action of chemical agents but it also may have some action in neutralising the effect of those chemicals.

3. The next section deals with sterilisation of instruments and materials. Sharp instruments need to be sterilised in such a way that their edges do not become dulled or corroded and, even with an effective sterilising agent, we still feel that there are some limitations inherent in the physical contour or configuration of some instruments, so that fine-bore hypodermic needles, the eyes of suture needles, complex instruments containing two or more parts in close contact like scissors, complicate the problems of sterilisation. We would like to hear about the magnitude of these limitations, then it will be possible to determine when various chemical agents may be used and when we must depend upon some other form of sterilisation. Finally, a word on the material acrylic, which is used in oral surgery and in general surgery for making the basic framework of prosthetic replacements for such parts as noses and ears; also, acrylic in the form of shavings and powders is used for the restoration of fatty tissues, as in asymmetry of the face, so that sterilisation of this material before insertion is necessary. It presents the additional problem that it is likely to craze under a very superficial or light attack from chemicals by a release of internal stresses.

Mr Wright: Mr. Jolly has posed a lot of questions which need the assistance of a scientific seer, if one exists, to answer them. We have to examine the problem conservatively and remember always that in choosing a disinfectant it is best to keep to those which we know to have produced results in the past, until one is convinced that a change is really necessary. If we are convinced that such a change is warranted, then it should be made with all haste.

The term "sterilisation" means complete destruction or removal of all micro-organisms and is rather loosely applied; thus, with skin it is impossible to achieve complete sterility. The application of antiseptics to the skin aims at what is called "virtual disinfection" or "adequate disinfection," vague terms, but methods of evaluation exist for determining whether the great majority of organisms have been destroyed. When we say "organisms" we generally mean in this connection vegetative organisms and don't include spores: this of course is a weakness.

As you know, the bacterial flora of the skin consists of two types: (1) the transients, which are on the skin surface and in the skin folds and (2) the residents, which are mainly in the crevices and deeper layers. The transients, which may include pathogens as well as non-pathogens, are not difficult to remove by the mechanical means of washing or scrubbing and are fairly readily attacked by suitable disinfectants. The more permanent population, the resident flora, is difficult to deal with. These bacteria reside in the sebaceous glands and deeper folds, and they may be carried up to the surface by sweat and skin secretion after sterilisation. Fortunately it does seem that most of these residents are non-pathogenic but some pathogens may become established. The search for satisfactory skin disinfectants is also made more difficult because of the rather involved methods that have to be used in testing them. *In vitro* tests which attempt to simulate the conditions obtaining in practice are very difficult to make. An indication of some of the difficulties is the carry-over effect that the chemical agent adsorbed onto the bacteria may have, when they are transferred to the culture medium. The common method used formerly was to dilute the test-sample to a point where the chemical agents would not be effective as a bacteriostatic. This is not always successful because bacteria retain some bacteriostatics on their surfaces so that growth may be prevented for a time, although the organisms themselves may still remain viable. Recently greater success has been obtained by methods of chemical neutralisation of the disinfectant in culture media.

There is little knowledge about the rate at which the activity of the antiseptic is lost. When an antiseptic is applied to the skin, how long does it remain in the molecular form in which it was used? That is, does the skin, or do the bacteria, detoxify the agent very quickly?

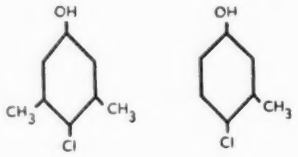
Another problem is to decide at what point a bacteriostatic agent becomes bactericidal. In this connection time is very important. Even when a single colony of some particular organism is taken there may be three types of cells present: one type which is very sensitive, another type which possesses an average sensitivity and a third type which is highly

resistant. Now, if a sample is taken soon after exposing the cells to the disinfectant all three types will be present and vigorous growth will occur. If it is taken later, only one type of cell may be present, the very resistant one; but, if it is taken still later, then the sample will be shown to be sterile, and yet we are dealing with one and the same species of organism. The trouble is that bacterial cells vary so much in their resistance that it is difficult to say what length of time is required for sterilisation.

The other difficulties in evaluation are encountered in trying to decide whether the material is toxic to the tissues and various ingenious tests have been devised to determine this tissue-toxicity and to produce a toxicity-index. Some tests employed for one chemical may be quite useless and erroneous when used for others. The well-known Rideal-Walker test was originally devised for phenolic substances but is of little use when applied to other bactericides of different chemical nature. A rather ingenious test has been devised recently for skin disinfectants and that is to shave the end of a mouse's tail, paint it with a culture of the organism being tested, dip the end of the tail into an antiseptic for a given time, then cut off the end of the tail and sew it into the peritoneum of the mouse and see if the mouse dies. This is a rather involved test but it does, I think, show whether the bacteria are merely held in stasis or whether they have actually been killed.

It is correct to say that we cannot chemically sterilise the skin without destroying it, but it is possible to reduce the bacterial population to very small numbers and sometimes to achieve almost complete sterility. Our concept of a satisfactory skin disinfectant demands that the agent should be rapid in action, have a wide range of killing-power against many kinds of organisms and have minimum tissue-destroying powers. It is sometimes difficult to avoid some tissue-damage and it may be a case of choosing the lesser of two evils. Tissue-damage can be repaired provided it is not too great. Disinfectants should not produce sensitisation and their action of course should not be neutralised by serum to any considerable extent. This means that a number of chemical agents are of limited usefulness: we cannot use all types of chemical agents for producing skin disinfection and consequently for this discussion we can limit our field to five or six groups.

(1) *Chlorinated phenols.* These compounds enjoy considerable success among the antiseptics. They are non-corrosive, non-staining, but are somewhat selective, being in particular less active against *staphylococci* and *Pseudomonas pyocyanea*, both of which are surgically very important. Two important representatives of this class are chloroxylenol (Fig. 1a) and chlorocresol (Fig. 1b).



(a) (b)

Fig. 1

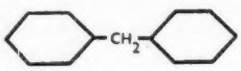


Fig. 1(c)

Chloroxylenol is used in popular brands of antiseptics and chlorocresol is used for sterilising solutions by the official process of "Heating with a Bactericide." They appear to act by combining with dihydrogenases but they also possess some surface-activity which may have an effect on bacterial members. Chloroxylenol preparations are caustic if used undiluted; they do not produce rapid sterilisation and do not dry rapidly. These properties in addition to selectivity severely limit their use.

Another compound in this class is hexachlorophene or G.11 (Fig. 1c), which is incorporated into surgical soaps to the extent of about 2%. The molecule includes two benzene rings, two phenolic groups and, as its name implies, 6 chlorine atoms. It is not very soluble in water but is soluble in lipoid tissues and consequently is surface-active to some extent. Its use is advocated by some American surgeons and by some bacteriologists. It has been shown, for example, that a single washing with a soap containing hexachlorophene is no better than with ordinary soap, but, if it is used constantly, say, several times each day, there is a prolonged effect due to the building up of a film of hexachlorophene on the skin which does reduce the bacterial flora. But other difficulties arise, because the organisms that are encountered are sometimes insensitive to hexachlorophene. It is much more active against gram-positive than gram-negative bacteria and there has been a tendency to overemphasise the usefulness of this compound because some of the tests used were not valid. There is a danger that it may

rreate a false sense of security and that people may neglect the customary scrub-up and alcohol-wash in favour of washing with this type of soap. One of the troubles in evaluating this type of molecule is that an amount as low as 1 in 5 million is taken over into agar cultures, growth is interfered with and concentrations as low as 1 in 20 million will considerably reduce the number of colonies. People have been somewhat influenced by tests which simply involve painting bacteria onto the skin, washing with hexachlorophene, then applying a pad to the skin and subsequently placing the pad onto a culture medium; they forget that a lot of the hexachlorophene is actually carried with the pad onto the medium. That has had a serious effect in tending to overemphasise its efficacy. Also, although it is claimed that this material does not give rise to allergic manifestations, this possibility cannot be ruled out: when a large molecule of any type is used some people will prove to be sensitive. The chlorinated phenols, then, have a severely limited application.

(2) *Cationic antiseptics.* These act because they exist in solution in the form of cations, i.e. positively charged radicles. There are two types: (a) the acridines (acriflavine, which is now quite out of date and has been entirely superseded by proflavine or the stainless aminacrine hydrochloride known as MONACRIN) and (b) the quaternary ammonium compounds. The acridines owe their effect to the fact that the molecule has a nitrogen atom present in its complex ring structure. Thus in proflavine the nitrogen atom is able to take on a positive charge which is able to compete with enzyme-receptor groups which normally combine with hydrogen atoms. The result is that the enzyme cannot function properly and the whole metabolism of the cell is disorganised. As a result these molecules produce bacteriostasis and, if they are allowed to stay in contact long enough, will have a bactericidal effect. They are however slow in action; they are not very surface-active and none of their effects is due to surface-activity; they have to diffuse through the membrane before they can come into contact with the enzyme. They are therefore not very useful for rapid disinfection of the skin but may be used for treating infections which are already established. They are not very irritating; they are not sensitising and have a fairly wide spectrum of activity. About the only organism which they do not attack with any degree of efficiency is *Pseudomonas pyocyanea.* Furthermore, the acridines are active in the presence of pus. Solutions can be autoclaved, so that sterile solutions can be obtained without affecting the stability of the chemical.

The quaternary ammonium compounds also owe some activity to their positively charged ions, but the molecules are also very surface-active. Originally discovered in Germany, they were hailed as the compounds which were going to solve all the problems of skin sterilisation. They have since been actively developed in all parts of the world and CETRIMIDE (cetyl trimethyl ammonium bromide) has been included in the British Pharmacopoeia. It is also known as CETAVLON, and ZEPHIRAN is a similar compound used particularly in the United States. The molecules owe their intense surface-activity to the presence of a long paraffin chain (sixteen carbon atoms in CETRIMIDE) which is hydrophobic, and a hydrophilic positively charged nitrogen atom. Under some conditions these substances are very effective. Their surface-activity ensures that they are adsorbed onto the surface of the bacterial cell and, if the concentration is sufficiently high, membrane disruption will occur. In low concentrations they may build up a layer and gradually penetrate the cell to cause enzyme-inhibition through competition with hydrogen ions as in the case of the acridines. Thus their mode of action may be the result of two effects. Dilutions as low as 1 in 50 thousand will kill *staphylococci* in a few minutes but their application is limited. They do not attack spores and are not very active against *Pseudomonas.* They are not effective against *Mycobacterium tuberculosis* and this consequently limits their use in hospitals, where contact with infected instruments and vessels is likely to be a problem. They are more effective against gram-positive organisms and are inactivated by soaps. This is easy to understand because a soap has a large negative anion which combines with the large positive cation and the effect is to reduce activity tremendously. So, if these materials are being used, as they sometimes are, for "sterilising" the hands, they must never be followed by the use of soaps. Their effectiveness is reduced as much as eight times by soaps, and perhaps more if the soap is concentrated. Also they exhibit only 1/50th of their activity in the presence of serum. Some people have been able to show that these substances may even build up a layer on the surface of the skin (a layer of the chemical substance over the skin surface) and underneath that layer the bacteria can develop and reproduce.

If ZEPHIRAN is applied for two minutes there is a reduction in the number of bacteria. When the skin is washed with soap which is not rinsed off, the ZEPHIRAN is precipitated and there is no reduction in bacterial count. The application of ZEPHIRAN (1 in 1,000), after rinsing off the soap, effected a reduction of 20 per cent. When an alcoholic solution (1 in 1,000) was used, the reduction of the bacterial

count amounted to about 85 per cent, but the solvent itself (alcohol 50% and acetone 10%) reduced the count by 70 per cent. and ethyl alcohol alone (70% solution) was even more effective than the ZEPHIRAN alone, so that, when those three agents (aqueous ZEPHIRAN, alcoholic ZEPHIRAN and ethyl alcohol) were compared over the same period of two minutes, ethyl alcohol showed itself to be very effective indeed. The activity of these chemicals then becomes rather doubtful. But, as against those figures, we do find that some clinical reports are very encouraging and that American workers have used these quaternary compounds extensively. One particular report shows that 18,000 cases have been treated with these compounds and no infection or irritation has occurred. There was an account in *The Lancet* recently of a new substance called saponium, which had been used for a period of two years in a maternity hospital and no infections of a dangerous type had occurred during that period. The picture is somewhat complicated, because frequently the results of *in vitro* tests (although they may condemn the disinfectant) are contradicted by clinical evidence. Just how valid such clinical evidence is remains to be seen. These substances are comparatively new compounds; they have been in use only since the War and their final evaluation has still to be made.

(3) The third group is the *organic mercurials*. Mercuric chloride was first introduced into medicine by Koch, who showed that spores could be killed by mercuric chloride. This observation was countered by another which showed that, if spores of *B. anthracis* which had been treated with mercuric chloride were subjected to the action of dilute ammonium sulphide, the spores germinated and developed normally on transfer to a suitable culture medium. This controversy has been going on ever since with both inorganic and organic mercurials. The trouble with the inorganic compounds is that they precipitate proteins; they are therefore very dangerous to use on tissues and are no good for instruments because they cause corrosion. Mercuric iodide is very rarely used now.

In order to overcome this difficulty of corrosion of instruments chemists prepared organic derivatives of mercury which did not produce mercuric ions and which were therefore non-corrosive and yet showed bacteriostatic properties. The three most widely used are MERCUROCHROME, MERTHIOLATE and METAPHEN. These organic mercurials are certainly bacteriostatic. They combine with the enzyme systems of bacteria through the sulphydryl groups, which are present in many proteins producing a stable complex of the type R—S—Hg—. Unfortunately, however, these compounds do not necessarily kill the organisms and it is possible to revive them. It was shown in 1948 by North, Engley and Mawson in U.S.A. that, if bacteria are inactivated by an organic mercurial, then injected into mice, they will grow because the resulting dilution allows the mercury to be removed and the infectivity of the organism is just as high as ever. A rather easier method is to take the bacteria which have been inactivated by the organic mercurial and plate them out onto agar containing thioglycollic acid (this contains sulphydryl groups which take away the mercury from the enzymes so that the bacteria revive). The sulphydryl group has the same effect as does British antilewisite (BAL), which is used in poisoning by heavy metals. These mercurial compounds may therefore produce a sense of false security. During the process of bacteriostasis, of course, phagocytic action may kill the organisms but that has never been proved At the present time the results of *in vitro* tests have certainly placed the organic mercurials under a cloud. They are, moreover, inhibited by serum and their activity is reduced by pus. However we must take into consideration the clinical picture, as people have used these compounds for some time without any great deal of trouble. Of course an attempt was made after these American workers published their results to justify their use by other tests and some people were able to show that, when spores of *Clostridium tetani* were injected under the skin, followed immediately at the same spot by some of these organic mercurials in sufficiently high concentration, *Clostridium tetani* was killed or certainly did not develop and that seemed to indicate that they may have some *in vivo* activity. But the present position is that they have been frowned upon by official circles in America: they have been deleted from the American Medical Society's publication "New and Non-official Remedies" and certainly they are not regarded as safe for the sterilisation of instruments. No one at all, not even the manufacturers themselves, will now advance the claim that they are useful in rendering instruments sterile. The *in vitro* testing of course may be invalidated by *in vivo* work, but, when using them for instrument sterilisation, notice must be taken of the *in vitro* tests.

Mercuric chloride is not very potent when applied for one minute and does not reduce the bacterial count very much. MERTHIOLATE applied for 3 minutes reduced the count to just about 55 per cent., MERCUROCHROME to 30 per cent. and METAPHEN to 10 per cent. MERCRESIN, which is another type of preparation similar to MERCUROCHROME, reduces the count but the solvent (alcohol 70 per cent. and acetone 10 per cent.), when applied for 2 minutes, itself

reduces the count to 30 per cent., so that the solvent alone is producing almost as much effect as when the bacteriostatic agents are present.

(4) The next group of compounds is the *halogens* and, although they include chlorine and bromine, chlorine is not used now on the skin. Iodine is the halogen which is of paramount importance. It has been used for a long time and we still find bacteriologists testing and comparing antiseptics for the sterilisation of skin and repeatedly finding that iodine holds its own under almost any conditions. The halogens act by attacking the proteins. They attach themselves to a nitrogen atom in an amino acid. This halogenation of the amino group occurs very rapidly and consequently iodine is a very rapidly acting antiseptic. Some advantages of iodine of course are that spores are more readily attacked by iodine than by most other antiseptics. It is inactivated by serum proteins to some extent and induces sensitisation or a type of allergic response. But it has a fairly wide bacterial spectrum and the bacteriostatic and bactericidal concentrations are practically identical. Iodine is therefore a very useful skin steriliser. The following are interesting comparisons. A 7 per cent. tincture of iodine, which is rather too strong for most purposes, when applied for only 15 seconds reduces the bacterial count to less than 10 per cent. An aqueous solution of iodine reduces the count very considerably but there are conflicting results which do not always support this. One per cent. iodine in 70 per cent. alcohol reduced the count to about 25 per cent. in a minute, but 70 per cent. alcohol alone after 2 minutes reduced the count to about 12 per cent! All the time there is this effect of the solvent and always we find that alcohol is important. This brings us then to consider the alcohols, the last of the five groups of chemicals chosen for this discussion.

(5) *Ethyl alcohol* is widely used because it is easily obtainable and is not very caustic; it precipitates protein a little and of course it has an astringent effect. We are accustomed to being told that it should be used in a concentration of 60-70 per cent. (about 70 per cent. is usually recommended) but these figures are based on early experiments in which dried films of organisms were used, whereas it is now known that some absorption of water is necessary before the alcohol becomes effective. The bacteria in a dry state do not allow the alcohol to penetrate very easily but these conditions do not usually apply when alcohol is used for skin disinfection, and it is now generally accepted that concentrations greater than 70 per cent. are equally or more effective. Many attempts have been made to replace ethyl alcohol by something more efficient.

The use of the less volatile isopropyl alcohol is advocated because it is more active against spores, and it is quite effective in a 100 per cent. concentration. It has a lower surface tension than ethyl alcohol and therefore its cleansing effect is greater.

The position, as far as it concerns the general use of ordinary skin antiseptics, has been summed up very well in an article published in the *British Medical Journal* recently.

In an experiment in which four organisms were used (*Streptococcus pyogenes, Pseudomonas pyocyanea, Bacterium coli and Proteus*) one per cent. iodine in 70 per cent. alcohol produced complete sterility on the skin surface in all cases, even in as short a time as 15 seconds. Aqueous iodine (1 per cent.) is not so effective against *Pseudomonas* and therefore has been abandoned. One per cent. aqueous CETRIMIDE is not very good. It is not active against *Pseudomonas* or *Bacterium coli* (gram-negative organisms) or *Proteus*. Two per cent. aqueous CETRIMIDE is no better; 4 per cent. only a little better. One per cent. CETRIMIDE in 70 per cent. alcohol gave good results. Ten per cent. CETRIMIDE in 70 per cent. alcohol again gave good results. ZEPHIRAN in 50 per cent. alcohol is not so good. Didinium chloride, another quaternary compound, gave quite good results but so did 70 per cent. industrial spirit. It is doubtful then whether it *is* necessary to add iodine or ZEPHIRAN to the alcohol. The only advantage is that these antiseptics will remain behind after the alcohol has evaporated and build up a layer which may be effective. This may apply particularly to iodine but, when aqueous iodine is proven not very effective against *Pseudomonas* and aqueous CETRIMIDE not very effective against any organism, the position is left somewhat obscure. It is therefore not very difficult to understand why materials found to be effective over the years continue to be used in the face of attractive claims made on behalf of newer compounds.

Well, I think I have spoken rather too long and I haven't really answered directly any of the questions which Mr. Jolly has put to me. I feel that I am not competent to answer a lot of them, because they concern rather specialised problems. I think that, as far as sterilisation of instruments and materials is concerned, one has to be very conservative. If one requires complete sterilisation of an instrument the only way is to use heat. For the storage of cleaned, sterilised surgical instruments several solutions are available but they themselves cannot be relied upon to destroy spores: for critical work it is necessary to use heat. The solutions that I refer to are

solutions of the quaternary salts. They are quite good provided the instruments have been sterilised first. They will prevent re-infection. The only disadvantage is of course that corrosion may occur, unless an anti-oxidant such as sodium nitrite is added. The use of formaldehyde is perhaps to be encouraged here: a lot of the old formulae for solutions used for storing instruments contained formaldehyde, but it is rather corrosive. It is oxidised to formic acid on exposure to the atmosphere and a good anti-oxidant is necessary unless the solution is renewed fairly frequently. So I'm afraid I haven't helped you very much at all — I have probably made the problem rather more complex than you thought it was. For that I am sorry but as time goes on it should be possible to arrive at a more complete solution of the problem of chemical sterilisation.

Professor Ward: We tend to think of the bacteria on or in the skin as parasites, but they live on dead matter and that fact entitles them to be classified as saprophytes. Most of them are rather harmless creatures as a rule.

Moreover the skin apparently has defences of its own. Nobody knows very much about these skin defences but it is well known that a culture of *Streptococcus pyogenes*, which has some reputation as a pathogen, can be painted on the skin and in a few hours' time cannot be recovered. It has vanished, been killed. That doesn't happen on the dead skin. What is it in the living skin that destroys the *Streptococcus?* Some people have ascribed it to the unsaturated fatty acids. It seems curious that the action ceases after death. Nobody has quite explained what happens to the unsaturated fatty acids after death, but the fact remains that when placed on the skin of a corpse the *Streptococcus* is not killed. Obviously such skin defences cannot act against the normal flora of the skin, so that they must have a differential action. There is also competition between various organisms and I have no doubt that they develop weapons of their own against their neighbours — an antibiotic effect. These are some of the factors concerned in the ecology of the skin and mucous membrane.

The people who interefere with the bacteria on the skin and mucous membrane can be classified as philosophers and scientists. Mr. Wright has been speaking about the clinical observations of certain surgeons who painted the skin with this or that chemical and reported that they had had no post-operative infections among, say, 2,000 patients. Personally, I wouldn't pay the slightest attention to such reports: I don't think they are worth the paper they are written on. Unlike most philosophers, these surgeons have faith. The trouble is they have faith in the wrong thing. They have faith in the chemicals that they have put on the skin instead of faith in the defences of the body, whereby organisms that are introduced into the skin after they *haven't* sterilised it are dealt with quite effectively. I've heard, year in and year out, these stories of the surgeons and how they never have any infections after they've used this or that disinfectant or of another surgeon who firmly believes that there's nothing better than soap and water. I think soap and water do remove some of the organisms, but soap certainly doesn't sterilise the skin. Yet the surgeons quote their hundreds of patients who have had no post-operative infection and attribute it to the disinfectant or to the soap and water, instead of to nature. The surgeons don't distinguish between surgical sterility, which isn't sterility at all, and bacteriological sterility which is much more difficult to attain and maintain. Nothing untoward may happen when an organism settles in the tissues but, if you introduce it into a culture medium, there is no protective (antibacterial) mechanism in the culture medium and growth occurs. We are faced with this same problem when we take blood from donors, put the blood into a bottle and distribute it for transfusion. The protective (antibacterial) mechanism, of which there is a certain amount in the blood, cannot be relied upon; hence we have to have true sterility on the skin, or as near an approach as possible. We have to be very much more careful and thorough than the surgeon in our attempts to sterilise the skin and even then a small percentage of bottles of blood are contaminated.

In choosing an antiseptic for the skin obviously considerations of speed of action are important. Thus MONACRIN is not a substance to be used for the sterilisation of the skin, simply because it doesn't act quickly enough. Then there is the question of the concentration of the antiseptic. For example, the makers claim that ZEPHIRAN acts in high dilution, but ZEPHIRAN diluted 1 in 300, 1 in 400, or 1 in 1,000 is useless as a skin antiseptic, as Mr. Wright has shown. To be effective, many disinfectants must be used in fairly concentrated solutions. Other points to be considered are the kind of bacteria likely to be met; and the ability of the disinfectants to penetrate. When we attempt to assess the effectiveness of methods of sterilisation of the skin, our techniques are generally faulty. Probably the only satisfactory method of finding out whether the skin is sterilised is to cut out the piece of skin and test it — not an altogether acceptable technique! In practice what is done is to test the surface for sterility. Probably most of the organisms are on or

near the surface, but to demonstrate that the surface is sterile is not to prove that the skin is sterile.

Next comes the problem of hypersensitivity. I would agree with Mr. Wright on the effectiveness of iodine and I would put it right at the top of the list. Iodine has been known for a very long time and is probably still the best skin antiseptic but, because of the risk of its causing a dermatitis, it is sometimes considered inadvisable to use it. This is especially so in an organisation like the Red Cross Blood Transfusion Service which depends on volunteer-donors. If only 1 per cent. of donors were to get dermatitis, the Service would be given a bad name; therefore, despite its excellence, iodine cannot be used to sterilise the skin in this Service. In its place we use something about which Mr. Wright was not very enthusiastic, namely chloroxylenol, but we use it concentrated. Unlike a hospital superintendent who is persuaded to use DETTOL, say, 1 in 100, where he might just as well use tap water, we use a 30 per cent. solution and in order to make it more efficient we use it with 70 per cent. alcohol (30 parts of DETTOL to 70 parts of alcohol). The alcohol reinforces and speeds up the action of DETTOL which itself in that concentration is a good skin antiseptic. Fortunately the mixture of 70 per cent. alcohol and DETTOL doesn't cause much trouble on the skin. The DETTOL remains on the skin, as Mr. Wright has pointed out, after the alcohol has evaporated.

Then there is this question of toxicity. It is not very important where skin is concerned. I have not seen reports of any experiments directed towards the sterilisation of the mucous membrane in the mouth. However I see no reason why that shouldn't be open to experiment. I should think that sterilisation of mucosa would be more difficult than of the skin.

We should, I think, give some thought as to what we do with our syringes. More and more preparations, be they drugs, vitamins, hormones, are administered subcutaneously or intravenously, so that the care of the syringe is important. The ordinary technique of looking after a syringe is to put it into alcohol. Now the syringe is used constantly in a hospital ward and, unless properly sterilised before each use, there is grave danger of transmitting the virus of serum hepatitis. Alcohol will not kill this virus: moist heat at or above 100°C. alone is effective.

In conclusion, let me emphasise again how effectively the human body protects itself against bacterial damage. Tonsils and teeth are removed in their thousands leaving raw surfaces exposed to bacterial invasion, yet untoward sequelae are the exception rather than the rule.

Mr. Hutchinson: Mr. Jolly mentioned the difficulty of sterilising scalpels, needles and other sharp instruments. Is there any serious objection to boiling them, as most of us do? Tests in England indicated that cutting instruments could be boiled without any effect on the cutting edge at all, providing that, while they were being boiled, they weren't mechanically damaged in the steriliser.

Mr. Jolly: I think that that problem is partly a financial one. Cutting instruments last longer if they are not subjected to repeated boiling.

Mr. Wright: Heat sterilisation of instruments is really the only satisfactory way. The Medical Research Council in Britain investigated very carefully the matter of sterilising syringes, particularly for intrathecal injections, which of course might result in a high rate of mortality if pathogens were introduced. Syringes should be separately packed into pyrex test tubes; needles should be attached to the syringes or, if that is not possible, needles should be placed in separate tubes with the point protected; the pyrex tubes are plugged with wool and then autoclaved or heated in an oven at 160°C. for one hour. The trouble with autoclaving lies in the use of moist heat; therefore the only way to prevent dulling of sharp instruments is to dry them afterwards. This is not practicable with an ordinary pressure-cooker type of autoclave. Hot air sterilisation avoids this difficulty.

However, if instruments are removed from a boiling-water bath or an autoclave into a solution which contains isopropyl alcohol, or into a 1 per cent. aqueous solution of CETRIMIDE containing sodium nitrite, the antioxidant action will prevent dulling of sharp edges or points.

Mr. Croker: What are the merits of using oil instead of water for sterilisation?

Mr. Wright: Liquid paraffin has been recommended, but to be effective the temperature must be raised to 150°C. for one hour. Temperature-control is rather difficult.

Mr. Hogg: Some years ago in this Hospital, Dr. Kirkpatrick experimented with chemical disinfectants and came to the conclusion that tincture of iodine was the best sterilising agent for mucous membranes. The sterility of mucous membrane after it has been treated with disinfectants could be quite easily tested when doing alveolectomies. I personally have

extracted teeth under the most septic conditions and under surgical conditions and I cannot say that I have ever seen any difference whatever in the result.

Mr. Oliver: It seems to me that more emphasis should be placed on that aspect of our problem which relates to time. There are many methods of sterilising skin: one, the four-day method; another, the six-basin method; what procedures should be adopted to attain sterility in a short time?

I think that mechanical methods should be considered. Sterilising the skin prior to a joint operation is a very different problem from sterilising mucosa. However, just as the skin is shaved and scrubbed, so should the oral structures be subjected to a prophylaxis and a mouthwash to reduce the number of bacteria.

There are occasions when surgical sterility is essential in the mouth, for example when operating on patients with rheumatic diseases and congenital defects of the heart.

The value of iodine as a disinfectant has been clearly established, but I understand that iodine does cause pitting of instruments.

Mr. Wright: I think it is a question of time and concentration. When iodine is placed onto the mucous membrane, the concentration will rapidly diminish and the time during which a sharp instrument, such as a needle, would be in contact with the iodine would be very short indeed. With stainless steel needles the damage would be negligible.

Dr. Sullivan: What is the efficacy of scrubbing the hands with soap and water? It is not always convenient to wear rubber gloves and, as Mr. Oliver mentioned, many of the methods of skin sterilisation are laborious and time-consuming.

Mr. Wright: There is a method advocated by Price in America. He recommends the use of ordinary soap (not hexachlorophene soap) without a brush for three minutes, trimming and cleaning the nails. The hands are dried on a sterile towel and then washed for 60 seconds in 70 per cent. alcohol. The surface organisms would doubtless have been removed but the first upwelling of perspiration would carry up some of the permanent flora and then, of course, it would be necessary to start all over again. If we are prepared to take the risk that those permanents are not pathogenic and to leave it to Nature as Professor Ward advocates, then that procedure should be satisfactory.

Dr. Goldsworthy: Mr. Wright has raised, I think, a very important point when he suggested that the alcohol placed on the hands and skin for 60 seconds might be undesirable. There is no doubt that an over-enthusiastic attempt to sterilise the operation area has been the means of offering the grossest insults to the skins of patients whenever there was time for it. They were scrubbed and made red-raw even before the antiseptic was applied. We have to use moderation in attempting to sterilise the skin.

Mr. Jolly: What is the efficiency of formalin vapour as a disinfectant, particularly for complicated instruments which cannot be boiled?

Mr. Wright: Even if the instrument is made of stainless steel it might be ruined by the formaldehyde vapour, because, as soon as formaldehyde is vaporised, there is oxidation to formic acid.

Mr. Jolly: Can you give us any idea of the time and concentration required?

Mr. Wright: Provided the vapour is saturated with formaldehyde, the sterilisation is very rapid and would be complete in a minute.

The Unerupted Cuspid — Co-operation Between Orthodontist and Oral Surgeon*

F. E. Helmore, D.D.Sc. (Syd.)

R. Y. Norton, M.D.S. (Syd.)

Part I.

Orthodontic Considerations.

R. Y. Norton.

There is one type of case which requires a particular approach irrespective of one's orthodontic outlook, namely, that in which a maxillary cuspid has failed to erupt. Such cuspids are often referred to as "impacted" but, in the majority of instances, "unerupted" is a better term, although the treatment of this condition is usually the same.

When a patient exhibits delayed eruption of the maxillary cuspid, a number of problems are immediately raised:

1. What has caused the non-eruption?
2. What is the position of the unerupted tooth?
3. What is the best course of treatment?

*Read at the 13th Australian Dental Congress, Brisbane, June, 1953.

(1) *Non-eruption.*

The etiology of non-eruption in many cases is very obscure and may be due to:

(a) The presence of supernumerary teeth, although these are rare in the cuspid area.

(b) The original position of the tooth germ, which is above that of the first premolar. Its movement from this area to its correct position in the mouth is fraught with hazard.

(c) Dense bone and fibrous tissue in the path of eruption.

(d) Over-retention of the temporary cuspids, which often obstruct or deflect the permanent successor.

In the majority of cases in which unerupted cuspids are present the arch development is good, while there is adequate space for the unerupted tooth. For these reasons many of these patients are not seen before 12-14 years of age.

(2) *Tooth position.*

Before any treatment can be considered, the position of the unerupted cuspid must be determined, here being considered purely from the point of view of orthodontic prognosis.

To assess tooth position, the following aspects are considered:

(a) Clinically the mucosa shows some degree of bulging, whether the tooth be labial or lingual; it is only in the case of a very deeply positioned tooth that no variation is apparent.

(b) Certain other teeth may be tilted, due to cuspid pressure. This is not always seen in the case of lingual, but nearly always in the case of buccal displacements. The lateral incisor (Fig. 1) and sometimes the central incisor are tipped, while the first premolar may be affected if the apex is well distal. (Figs. 2 and 3).

(c) A thorough radiographic examination must be carried out, and should include a small film taken for normal cuspid angulation. Another with the tube at right angles to the sagittal plane is essential to give a second angulation. A correctly angled occlusal view is of assistance but not essential; this aspect of angulation will be explained in part II.

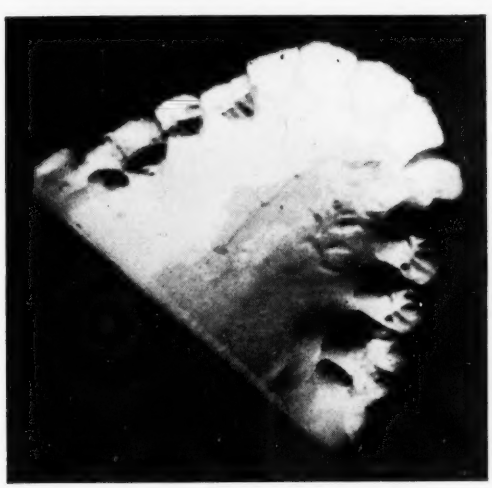


Fig. 1

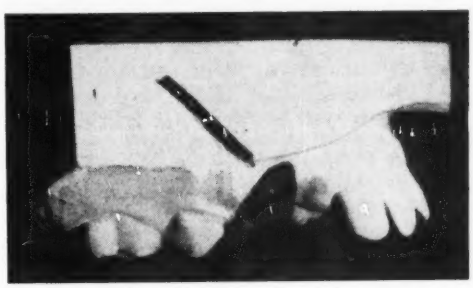


Fig. 2

From an orthodontic aspect Adamson[1] has classified the prognosis of positioning cuspids in three groups.

Group 1.

The cuspid, either labial or lingual, is almost vertical, with its apex possibly as far distal as the 1st premolar, while the crown may approximate the distal of the lateral incisor — prognosis is good.

Group 2.

The cuspid is lingually placed and the apex may be as far distal as the distal of the 1st premolar, while the crown may lie to the mesial of the lateral incisor — prognosis is good except in cases where the two extremes exist.

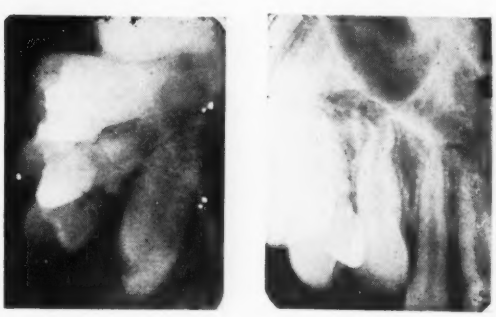


Fig. 3.—X-rays before and after exposure.

Group 3.

These are more or less horizontal, so that the apex is in the 2nd premolar area while the incisal tip may be up to the mid-line—prognosis is unpracticable from all aspects.

The above comments apply primarily to palatally placed cuspids, because only in rare cases do those on the labial remain unerupted. When this occurs, they usually lie high in the buccal sulcus and the prognosis must be considered individually in each case.

(3) *Treatment.*

Having considered the above facts, together with others such as tissue health, oral hygiene, general occlusion, general prognosis, and age of patient, one of two decisions must be arrived at:

(a) To have the tooth surgically removed—the sequelae of leaving such teeth *in situ* is well known. (Fig. 4).

(b) To move the tooth to its correct position after surgical exposure.

Fig. 4.—Delayed treatments of unerupted cuspid for 2 years resulting in damage to lateral incisor necessitating extraction.

Until several years ago the usual practice was to follow the "Stimulation Technique." The main virtues in this approach seem to be the removal of overlying bone which may act as a mechanical obstruction and the "wiggling" of the tooth, which in theory stimulates the latent biological forces which produce tooth eruption.

Fig. 5

After having closely followed the history of some eight cases handled in this way, it became clear that results of practical value were not being obtained. As these cases were handled by three different surgeons, the variation in surgical approach can be discounted.

In six cases the report was received at the time of exposure that the tooth was favourably placed. Notwithstanding, this examination of the results showed:

(1) Tooth erupted in 7 months—1 case.

(2) No tooth eruption in 8 months—1 case.

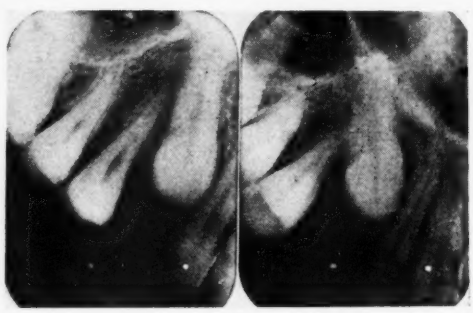
(3) No eruption in 18 months—4 cases.

(4) No eruption in 30 months—1 case.

(5) No eruption after 2 years with 2 stimulations (surgery: December 1950, December 1951)—1 case. (Figs. 5 and 6).

All of these patients were 12 years of age or over at the time of surgery, which means that, if and when the cuspid erupts, full orthodontic treatment may be proceeding up to the age of 14 or 15 years of age.

Following due consideration of the histories mentioned above and taking into account the uncertainty of eruption and its tardiness when eruption did take place, the whole problem was reviewed in an effort to develop a more satisfactory approach.



April, 1952 December, 1952

Fig. 6

Part II.

Surgical Aspects.

F. E. Helmore.

It may well be suggested that a specialist only exists to solve problems which are somewhat outside the scope of ordinary general practice, and therefore it is an interesting situation when one specialist poses a problem to a colleague in another field.

As the science of dentistry advances and becomes more complicated this situation becomes more and more common, and the solutions achieved in a spirit of co-operation become correspondingly more satisfactory, to the benefit not only of the practitioners concerned but, what is more important, to the patient, whose interests must always be the primary consideration.

Fig. 7

The orthodontist in this case has posed a problem in the treatment of unerupted cuspids. What can the oral surgeon do to make the orthodontic problem easier and the end result better?

In this paper is presented a co-operative approach made largely with the idea of producing a sound basis of treatment which has been proved to get results.

It is the author's intention to describe the surgical technique which has been found most satisfactory in the literature. It is of interest to the surgeon that the few references made to this problem of unerupted cuspids is found in orthodontic journals and not in surgical publications.

As in all forms of surgery, the important first step is thorough examination, largely to determine the exact position of the unerupted tooth. Clinically, enlargement of the palate or buccal plate of bone may give useful information if present, but such tumour may be very difficult to detect, particularly in an arch where other teeth are malposed.

Displacement of erupted teeth is frequently significent and gives information not only in relation to surgical procedure but also to orthodontic prognosis. If it be remembered that the crown of an erupted tooth moves, or perhaps rather tilts, in the reverse direction to the pressure of the unerupted tooth if the pressure is exerted near the apex of the root, and in the same direction if pressure is exerted near the crown, useful information may be obtained and the amount of tilt is a fair indication of the pressure being exerted.

However, radiographs are necessary for final diagnosis.

Any radiograph of the area may reveal that there is an erupted cuspid present but there is no region in the mouth in which an x-ray may be more misleading. This is so, even in routine radiography of what may be termed the corners of the arch, and it is even more so when the cornerstone is missing.

Basically, two x-rays are essential: firstly, a true periapical view of the area the cuspid should occupy. (Fig. 7). This should be taken as if the cuspid were erupted in normal position, with correct vertical and mesio-distal angulation for such normal conditions. Care must be taken to avoid x-raying for where the operator imagines the tooth to be actually lying, because the information required is the relationship between its correct position and its actual position. A periapical film taken as if for normal conditions will yield this information and permit of a correct surgical diagnosis.

Secondly, a true occlusal view (Fig. 8) angled so that the rays are directly parallel with the long axes of the incisors on the affected side, thus making them appear on the films as

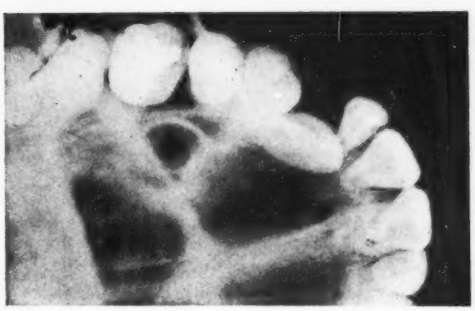


Fig. 8

Fig. 11

Fig. 13

Fig. 12

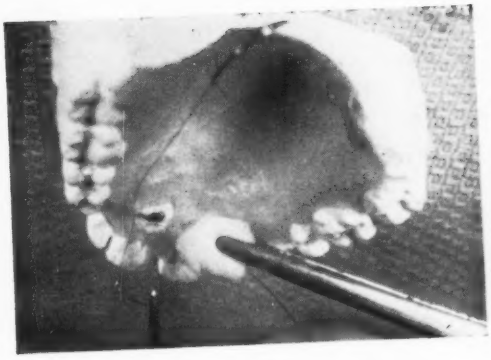


Fig. 14

cross-sections. (Fig. 9.) Such a film will show the relationship of the crown of the cuspid to the roots of the incisors, a point of major importance in surgical exposure of the crown. It is of interest to compare figures 9 and 10—these show the same patient but the occlusal exposures were taken with different angulation.

Fig. 9.—Poor angulation.

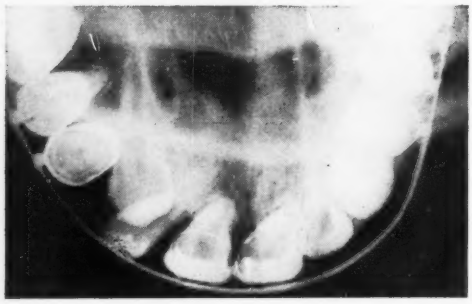


Fig. 10.—Correct angulation.

Further x-rays which may be of value following location as above are a direct view through the tip of the crown and, where there is any doubt as to its bucco-palatal position, the employment of the "tube shift method."

Let it be emphasised that a great deal of trouble may be saved if thorough radiographic examination with careful technique is carried out.

Over a period three main surgical methods have been used in the attack on this problem. They are:

(1) Simple excision of overlying tissue.

(2) Raising of a muco-periosteal flap, removal of bone, stimulation of the tooth by slight instrumentation, and replacement of the flap. This is referred to as the "Stimulation Technique."

(3) Raising of a muco-periosteal flap, removal of the coronal sac, channelling of the bone, cutting a window in the flap and, after re-suturing, packing to prevent healing over of the soft tissues. Thus, a cone-shaped opening is formed at the end of which the crown of the cuspid may be clearly seen.

Method (1) fails because it does not allow the surgeon access to the crown to ensure its freedom. It is in fact only a soft tissue excision which achieves very little and any value it may have is quickly lost by re-growth of soft tissue.

Method (2), that is the "Stimulation Technique," is more useful but fails on the following counts:

(a) Unless the orthodontist is present at the operation, he never sees the actual position of the tooth.

(b) Although any bone delaying eruption is removed, the soft tissue which is replaced still acts as a barrier and, in fact, the position may be worsened by the formation of scar tissue.

(c) When results are obtained by this method, they are slow for the reasons just mentioned.

(d) The attachment of any orthodontic appliance to aid eruption is not possible, if such aid is required.

Method (3) is therefore recommended and, hence, the actual technique of its application will be described in some detail. It has none of the disadvantages ascribed to (1) and (2) and, in addition, it has some positive advantages.

(i) There is full exposure of the crown of the unerupted tooth, enabling its exact position to be determined visually.

(ii) Such exposure is permanent, so that the orthodontist can accurately estimate the prognosis and plan his own campaign.

(iii) No scar tissue is formed over the tooth to prevent or delay eruption.

(iv) Results are speedy because of lack of mechanical obstruction to eruption (scar tissue, etc.).

(v) The orthodontist may, if necessary, attach appliances at leisure.

(vi) The surgical pack in the opening provides a high degree of immediate post-operative comfort, as occurs following gingivectomy.

(vii) The psychological effect on the patient and parents is good in that the tooth can be felt with the tongue and even seen by the parent, which creates a feeling that concrete results are being obtained.

Surgical technique.

The following description is presented under five headings:

(1) Design and elevation of flap.

(2) Removal of bone to form a channel to the crown.

(3) Cutting of the window in the flap.

(4) Packing and suturing.

(5) Post-operative care.

(1) *Elevation and design of flap.*

The flap design is similar to that employed for the removal of a palatal cuspid but is more conservative.

A vertical incision is made distal to the first bicuspid and carried up into the palate about half way to the median line. (Fig. 11). The gingival margin is freed to the centre of the central incisor on the opposite side and the muco-periosteum stripped back from the bone. It is retracted by clipping a pair of Allis forceps to the body of the flap (not to the gingival margin), the forceps being drawn to the opposite corner of the mouth. Damage to the vessels in the naso-palatine canal and to the gingival margins around erupted teeth must be avoided.

Such a flap will usually provide adequate access but may be extended by increasing the vertical incision, avoiding over-extension which may cut the greater palatine artery and/or vein. (Fig. 12). It may also be extended by undermining the flap with a blunt periosteal elevator, thus allowing a slight degree of stretch to be established.

(2) *Removal of bone to form a channel to the crown.*

Burs should never be used for this purpose, as it is easy to damage the crown of the tooth.

Chisels, preferably with hand pressure for psychological reasons with a young patient or with very light mallet blows or, best of all with a controllable automatic surgical mallet used very gently, are the instruments of choice.

As soon as sufficient access is established, the sac should be curetted away so that the crown may be seen to avoid accidental damage. The bone is then removed until the opening is slightly larger than the crown, particular care being taken in relation to the shoulders of the tooth. Any remaining coronal sac is removed with curettes and eruption stimulated by gently moving the tooth in all directions with a suitable elevator. This may be described as "wiggling" the tooth, an unscientific but descriptive term.

It should now be possible to see the crown clearly, practically to the cemento-enamel junction.

(3) *Cutting of the window in the flap.*

The flap is replaced and the approximate position of the window determined by piercing it with a sharp probe immediately over the crown.

When the flap is re-lifted, the window may then easily be cut with curved scissors or a scalpel. If such window, to ensure complete clearance of the crown of the cuspid, involves the gingival margin, usually between the central and lateral incisors, there need be no concern. This gingival margin would in any case be destroyed as the cuspid erupts and will regenerate as the cuspid moves into its correct position.

(4) *Packing and suturing.*

The window having been cut, the flap is firmly sutured into position.

A suture is then placed through two convenient sides of the window and the loop pulled back to allow insertion of the pack. (Fig. 13).

The pack, consisting of zinc oxide mixed to a putty-like consistency with a good binding of cotton wool, is then inserted with light pressure, the loop tightened over it and tied. This one suture will ensure the retention of the pack in most cases for 6 or 7 days if 00 catgut is used. (Fig. 14). The pack should not be removed earlier than this as the object is to create an epithelialized funnel to the crown of the tooth. Early removal may also be followed by quite severe haemorrhage.

(5) *Post-operative care.*

The patient should be examined 24 hours after operation to ensure that the flap is in good condition and the packing satisfactory.

Routine warnings are given to the patient and parents in regard to care being taken to avoid disturbance of the pack, a soft diet prescribed and instructions as to cleansing given.

Packs are removed after 6 or 7 days and the area spray-irrigated to remove any debris.

It should then be possible to see the crown of the unerupted tooth at the top of a cone-shaped hollow.

A further examination should be made about a week later when the walls of the cone will be fairly well epithelialized and the patient may be referred back to the orthodontist.

Attention has been given mainly, or rather entirely, to the cuspid which is in a palatal position. This is the most usual anomaly encountered and the one in which the oral surgeon is most usually called to help.

Buccal displacements are more unusual and do not fall into the same definite classification. They have, therefore, to be treated an their merits, although the same general principles are applied.

The following comments may be made:

(1) The operation is not difficult, lengthy or trying for the patient. At the same time, it must be performed with considerable care to avoid damage to adjacent teeth.
(2) There is very little post-operative discomfort.
(3) Eruption of the tooth takes place more quickly than when any other method is used. In fact, results are achieved in weeks where other methods take months.
(4) Orthodontic comment where this method has been used has invariably been favourable, thus leading to the suggestion that it is, in the present state of our knowledge, the method of choice.
(5) Collaboration in two specialist fields has been of considerable benefit to the patients treated.

Case Reports.

Over 30 cases have been treated with the packing technique and in only one, where the cuspid position was in Group 3, has it not been possible to maintain permanent exposure of the crown. Due to this, the placement of pins, with all its associated dangers, has been found unnecessary. In all cases the tissue health has been maintained, while there has been no evidence of any damage to the gingival margin.

Case D. W.—girl aged 15.

Upper right cuspid was exposed in March, 1951, bone removed, tooth stimulated and position of tooth was reported as very favourable

Fig. 15 (right side) Fig. 16

for eruption. X-rays in July, 1951, and October, 1952 (Figs. 15 and 16) showed little to no alteration in position, while clinically the tooth had not appeared. (Fig. 17). In November, 1952, the method described as "exposure and pack" was used and immediate eruption occurred. (Fig. 18).

Case R. N.—girl aged 20.

Models, 21st January, 1953, showed a slight swelling lingual to the upper right lateral, (Fig. 19) while x-rays showed the cuspid to

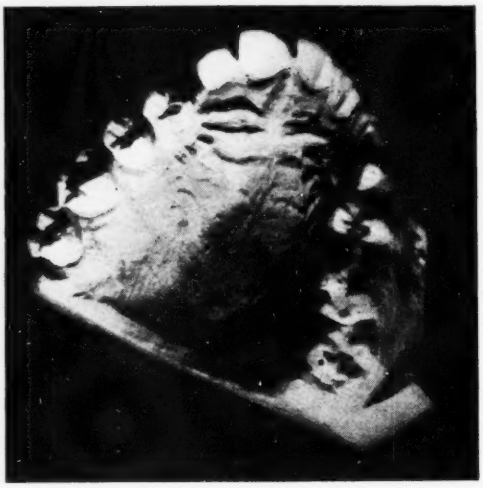


Fig. 17

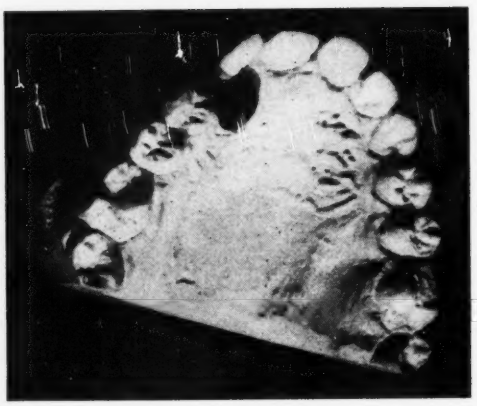


Fig. 18*

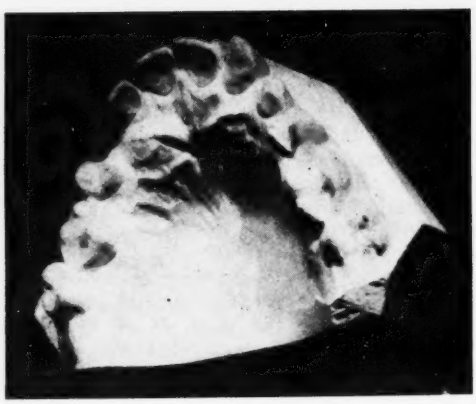


Fig. 19

*Erupted teeth on this and following models shown in black.

be lying in a favourable position. Again the "exposure and pack" technique was carried out. Models, 10th March, 1953, showed the degree of eruption which had occurred. (Fig. 20). *This tooth has now been moved to its correct position with a fixed lingual appliance.*

Fig. 20

Case J. B.—girl aged 13.

In May, 1952, there was no clinical evidence of the position of the upper left unerupted cuspid; radiographically the tooth was lying in a favourable position. (Fig. 21). The "exposure and pack" technique was used and the cuspid appeared at the bottom of a shallow

Fig. 21

Fig. 22.—Before surgery.

depression lingual to the lateral incisor. Gingival tissues about the lateral incisor, which were excised during surgery, returned to normal condition and have since satisfied an examination by a periodontist. (Figs. 22 and 23.)

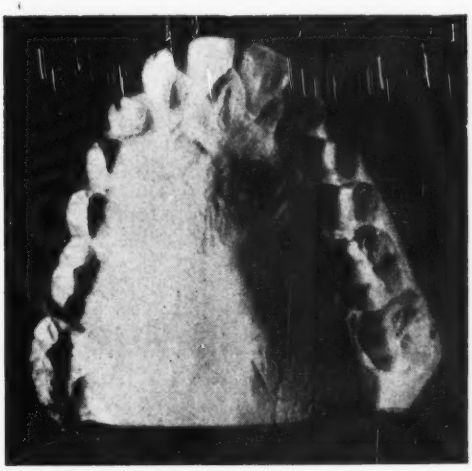


Fig. 23.—After surgery.

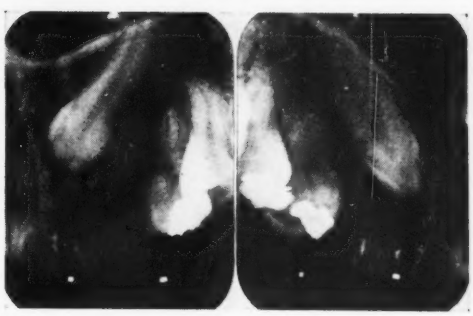


Fig. 24

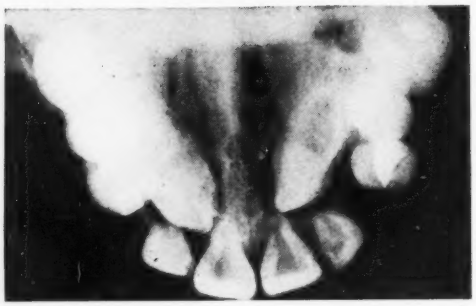


Fig. 25

Case M. T.—girl aged 14.

Both upper cuspids were unerupted and lying palatal to the upper laterals. Radiographically there appeared to be some damage to the upper laterals but these were quite firm. (Figs. 24 and 25) The "exposure and pack" technique

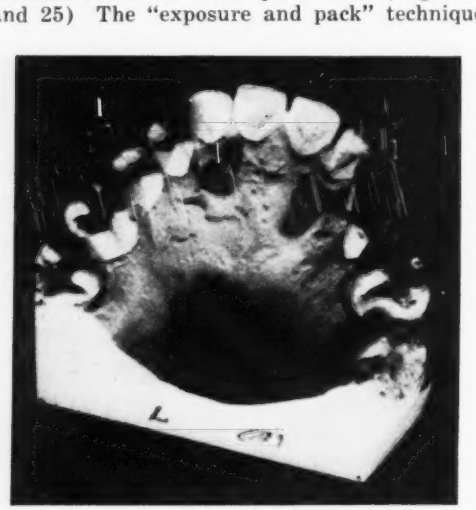


Fig. 26

was carried out on 10/2/53. Models, April, 1953, showed both teeth in the mouth with normal tissue health. (Fig. 26). These teeth can now be positioned with a lingual appliance.

Fig. 27

Case E. D.—male aged 23.

Arch form was excellent with both temporary cuspids in place. X-rays showed both permanent cuspids lying in favourable positions but tending to the lingual. Temporary teeth were removed, "exposure and pack" technique carried out. Eruption of these teeth was spontaneous and in a month was sufficient to allow movement by a lingual appliance. (Fig. 27).

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Some Considerations Prior to Experimental Fluoridation

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The evidence confirming the use of water fluoridation as a means of partial caries control has been built up by extensive investigations during the past twenty years, until today it is, in principle, widely accepted. Many criticisms have been raised and overcome, but at the present time the most frequent argument against the efficacy of fluoridation is whether or not its benefits are permanent.

In England, Weaver[1] showed that twelve year old children in a non-fluoride area** had the same D.M.F. rates as fifteen year old children who had lived continuously in a district that had 1.4 p.p.m. of fluoride in the domestic water. These figures showed that the fluoride had apparently caused a three-year delay in the incidence of caries, and on this basis Weaver warns that it is very misleading to state that fluoridation will reduce the prevalence of caries by fifty by sixty per cent. Continuing the same argument, several other writers have suggested that fluorides will not be of any dental benefit to adults.

However, Russell and Elvove[2] showed clearly that caries inhibition extended undiminished into adult life. This was also confirmed by the earlier work of Deatherage.[3] These results and others indicate that Weaver's interpretation of his surveys should not be regarded as a serious objection. The fundamental fact cannot be avoided: the average child or adult who has lived in a district that has a negligible amount of fluoride on the water, will, at any given age, have at least twice the number of D.M.F. teeth than

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**In this article a district in which there is a negligible intake of fluoride from either water or food is referred to as a non-fluoride area, while a district in which there is approximately an optimal intake of fluoride for caries control is referred to as a fluoride area.

if he had continuously used water containing the optimal concentration of fluorine.

This paper has been written in an endeavour to present briefly several problems which should be considered before experimental fluoridation is undertaken in any locality. These will be discussed under the following headings:

(1) What level of fluoridation should be adopted.

(2) Consideration of the existing level of fluorine intake, (a) from drinking water, and (b) from sources other than water.

(3) Determination of the caries rate of the population in question.

(4) Determination of the pre-fluoridation incidence of mottled enamel.

(5) Education of the community involved.

(1) *What level of fluoridation should be adopted.*

The often quoted statement, that the presence of 1.0 part per million of fluoride in the drinking water is the optimal concentration which will produce maximum caries reduction with minimum incidence of fluorosis, is misleading. It is true for a temperate climatic zone only.

Obviously less water will be consumed in a cold climate than in a hot one. For example, Gard[4] reports that in Norway 2.5 p.p.m. in the water is not associated with the presence of any mottling of enamel; this content in a temperate region will cause a significant incidence of these effects. In the Punjab where the water intake is four to five times that in a temperate climate, 6 p.p.m. is associated with severe dental and skeletal fluorosis, yet in the U.S.A. (and other countries) people have lived their entire lives in areas having a similar fluorine content in the drinking water, and have not suffered any skeletal disturbances.

It is the quantity of fluoride consumed during the developmental period of the teeth that is important. The optimal total intake, from food as well as water, during this period would be one milligram per twenty to twenty-five kilograms of body weight per day.

This leads directly to the question of whether it would be a desirable and practical refinement for those districts in which the winters are extremely cold and the summers are extremely hot, to adopt the policy of adding less fluoride in summer than in winter. In this connection it is interesting to note that Peirce[5] reported that sheep in Adelaide consumed forty per cent. more water in summer. Adelaide does not have an extreme climate.

If there is a similar water-intake variation in humans then this matter would deserve some consideration. For example, in the case where the enamel of the fissures of a molar was largely formed during the very cold winter of a district which had a water-fluorine concentration of one part per million, the water intake would be reduced to the level where the anti-caries action would be significantly less than the optimum.

(2) *Consideration of the existing level of fluoride intake.*

(a) *From water.*

The necessity for the determination of the fluoride content of the domestic water prior to fluoridation is obvious.

Jones[6] conducted an extensive survey of waters throughout New South Wales. In general none of the surface waters contained more than 0.3 p.p.m. Two of the bore waters supplying domestic needs at Warren and Carinda contained approximately 1.2 p.p.m. of fluoride.

A survey of Victorian water supplies is being conducted by the Victorian Department of Health.

(b) *From sources other than water.*

Analysis has shown that the average American diet will contribute approximately 0.2 milligrams to the total daily fluoride intake.[7]

In America tea is not widely used. A brew of tea contains 0.9 to 1.5 p.p.m. of fluorine[8]; therefore, a cup of tea will contain approximately 0.1 to 0.2 milligrams of fluoride. If in any country tea formed a significant part of the diet of the children aged up to four to five years (when incisor calcification is complete), then it would deserve special consideration when assessing the amount of supplemental fluoride to be given.

Contrary to the view expressed by Amies and Pincus[9], the presence of milk in tea would probably not alter the extent of the absorption of the fluoride contained in it. This is due to the fact that when this element is present in trace quantities only, the solubility of the particular fluoride compound (for example, calcium fluoride, where the calcium is being supplied by the milk) does not have any significant effect on its absorption.[10]

Sea foods, especially if the bones are eaten as in some tinned products, are the richest food source of fluoride; up to ten p.p.m. is quite usual.

In order to verify that there was no unexpected extraneous source of fluoride, some samples of urine could be examined, or the foodstuffs could be analysed. The basis of the urinalysis depends on the fact that the quantity of fluoride excreted in the urine reflects the quantity consumed.[11]

(3) *Determination of the caries rate of the population in question.*

There are two general ways in which the benefits of fluoridation can be measured:

(a) By comparison with a similar type of community whose water supply has not been treated.

(b) By comparing the pre-fluoride caries rates with those of the same community at various periods after the commencement of fluoridation.

This latter method is not as accurate as the former because there would be no knowing that any changes in D.M.F. rates were not due to factors other than fluoride.

Which caries index should be used: There are many caries recording systems. They all have one aim, that is, to express as a number the clinical condition of the mouth in relation to caries experience. They can be divided arbitrarily into three groups:

(a) The D.M.F.-teeth index, which is merely a statement of the number of teeth which are, or have been affected by caries.

(b) The D.M.F.-surfaces index, which is a statement of the number of tooth surfaces involved with caries. Missing teeth are usually regarded as having had three surfaces affected.

(c) Indexes such as those of Mellanby, Bodecker, and Knowles.

In dental survey work those in group (c) are not often used because (i) they are somewhat complicated as compared with the D.M.F. systems, (ii) they require judgment by the examiner who has to determine the extent of tooth structure involved, (iii) it is doubtful if they yield a more accurate result than (a) or (b).[12]

The choice of a recording system lies between D.M.F.-teeth and D.M.F.-surfaces. One important fact to be borne in mind is that we are to compare population groups which we can expect will have widely differing dental health. Therefore, the question arises as to whether the D.M.F.-teeth index is of sufficient scope to fully differentiate between these two groups.

This problem can be made clearer by assuming a particular case. A child has four defective first molars, one has occlusal caries, one has caries on two surfaces, and the other two have been extracted. Another child has each of its first molars affected by caries of one surface only. Under the D.M.F.-teeth index both children would be recorded as four, which would falsely indicate an equal caries experience. However, according to the D.M.F.-surfaces index one would be nine (1+2+3+3), and the other would be four.

Persons from a district having a negligible quantity of fluorine in the domestic water will have more carious surfaces per carious tooth, as well as approximately five times the number of extracted teeth, than if the water had contained the optimal concentration of fluorine. Thus it can be seen that the two instances quoted above might well refer to a non-fluoride and a fluoride area.

It can be estimated from the results of one survey (of adults) that the D.M.F.-teeth rates in a non-fluoride and a fluoride district were in the ratio of 2.4 to 1, whereas the D.M.F.-surface index indicated a ratio of 3.2 to 1.[2]

In attempting to impress the public, as well as those persons responsible for the decision to fluoridate water, it is an advantage not to underestimate the expected dental benefits, as the D.M.F.-teeth system appears to do.

Another factor favouring the D.M.F.-surfaces recording method is that it would give a comparison between the caries reductions of the various dental surfaces.

However, from a practical point of view it has three disadvantages:

(i) It is more complicated and cumbersome, and requires more time in recording.

(ii) The operative extension of some cavities so that non-carious surfaces are involved in the filling is a basic defect.

(iii) If its potential accuracy is to be utilised, caries diagnosis should be carried out with the aid of x-rays.

The use of x-rays: If a tooth had an obvious occlusal cavity and a very small mesial one, the failure to observe the mesial caries, during a mirror and probe examination, would not affect the accuracy of the result, as long as the D.M.F.-teeth system was used. However, if the D.M.F.-surfaces index was used it would represent a fifty per cent error. This factor assumes more importance when it is considered that the smaller lesions will be prevalent in the group receiving the fluoride. Therefore, if x-rays were not to be used, which in any comparatively small pilot experiment would be undesirable, then D.M.F.-teeth should be the index of choice, even though it is not fully satisfactory.

X-rays will usually reveal approximately 25 to 45% more cavities than a mirror and probe examination alone. A recent survey in Canberra showed this figure to be 36%.[13] When expressed in terms of D.M.F.-teeth the discrepancy would be approximately 15 to 25%.

Correlation between different examiners: It has been shown that dentists vary in their accuracy of diagnosing caries; also there is a good deal of variation in their ideas as to whether some small cavities of the pit and fissure class are actually carious or not.

With this problem in mind a recent investigation was carried out to observe the correlation between the results when one group of children was examined by three different

examiners.[13] The dentists in question had attempted to standardise their criterion of caries diagnosis. Results showed an insignificant difference between the three series of examination; therefore different examiners could be used satisfactorily on a prefluoride survey.

(4) *A survey to determine the prefluoride prevalence of mottled enamel.*

Mottling of enamel is caused by many factors other than fluorine, and therefore its prevalence should be determined before fluoridation is commenced. It appears highly probable that the amount of mottling attributed to fluorine has been greatly exaggerated.

Dental fluorosis as a result of consuming approximately 0.05 milligrams of fluoride per kilogram of body weight per day (this would be the total intake in a temperate climatic zone where the drinking water contained 1.0 to 1.5 p.p.m. of fluoride) is not an important problem. In epidemiological surveys no cases involving brown staining have been recorded; mild mottling, which is observable as white opaque areas in the enamel, affected about two per cent. of the population; very mild mottling affected approximately twenty per cent.

However, an investigation in a non-fluoride area revealed that twelve per cent. of the children had white opacities in the enamel of at least one tooth, while two per cent. had yellow, and one per cent. had brown discolourations.[14] It has also been reported that in another district where there was a negligible quantity of fluorine in the drinking water, one or more enamel opacities were observed in eighty-seven per cent. of the group examined.[15] With these facts in mind several writers have warned of a possible error in surveys dealing with the prevalence of dental fluorosis, and that many instances of enamel mottling in regions having fluoride in the drinking water have been wrongly stated as being caused by fluorine.

There is no definite way of differentiating between mottling caused by fluorine or by other factors.

A consideration of the foregoing discussion indicates that it would be necessary to carry out a survey to determine any change in the prevalence of mottling subsequent to fluoridation.

(5) *Education of the community involved.*

The education of the public in various aspects of fluoridation is a problem that should be considered. Some factors requiring emphasis are:

(a) Fluoride will not prevent all caries; therefore the use of other preventive measures should be continued.

(b) The anti-caries effect is not confined to children; the future generation of adults will also benefit.

(c) The inhibition of caries will not take place immediately after the fluoridation has commenced.

(d) The trace of fluoride used will not cause any detectable change in the water.

(e) No systemic toxic effects will result.

(f) Industrial processes will not be affected.

SUMMARY.

1. The total daily intake of fluorine should be adjusted so that children up to the age of eight years will be ingesting approximately 0.05 milligrams of fluorine per kilogram of body weight.

2. It seems highly probable that the D.M.F.-teeth index will not fully differentiate between two groups having greatly dissimilar caries experience. It tends to under-estimate the benefits of fluorine. Also it would provide less information than the D.M.F.-surfaces method.

3. D.M.F.-surfaces index is the one of choice, providing x-rays are used to aid caries diagnosis.

4. Enamel mottling can be caused by factors other than fluorine, therefore a survey to determine any change in the prevalence of mottling after fluoridation would be desirable.

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The Pathology of the Dental Pulp*

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Introduction.

The dental pulp is essentially a loose fibrous connective tissue and one would therefore expect that its reactions to external environmental changes would be much the same as in other such tissues. That these are not so is common knowledge, and the essential reason for this difference is the unusual nature of the anatomical environment of the pulp.

It is the purpose of this paper to discuss the manner in which this environment affects the responses of the pulp to common injuries or stimuli and also the treatment of a pathological condition of that tissue.

The tissue of the dental pulp is unique in the animal body in that it is enclosed within a narrow unyielding chamber whose only communication with the rest of the body is through the minute apical foramina, which transmit its blood, lymph and nerve supplies.

The position is analagous to that of a narrow-mouthed bottle full of water and containing a large number of small fish. It is at once obvious that there will be a very definite limit to the number of fish which can live comfortably in such a fixed quantity of water. Of equal importance in maintaining their healthy life will be the quality of this water. This will depend on the entry and exit of nutrient and waste materials through the narrow mouth and the maintenance of correct pressures within the fluid. In other words the chemical and physical state of this fluid must vary within only narrow limits and the greater the population the narrower these limits. In such a confined space, if either of these should vary beyond such limits, even for a short period, one or more of the contained animals will suffer in health or die.

If we substitute tissue fluid for water, cells for fish and the walls of the pulp cavity for the bottle, we have a very similar state in the human dental pulp.

In common with other tissues the dental pulp responds both passively and actively to external environmental influences and it is convenient to discuss these separately. I intend to devote considerable attention to the more passive degenerative and atrophic changes because, although often devoid of noticeable clinical manifestations and less spectacular than the active inflammatory changes, they can be equally lethal to the life of this tissue. Moreover, there are many aspects of such changes which offer opportunities for further study.

Passive Changes.

(a) *Degeneration.*

Nature has endeavoured to minimise the difficulties occasioned by the anatomical environment by providing a much larger proportion of tissue fluid to cells than is found in other fibrous connective tissues. Nevertheless, the physical and chemical states of this fluid must be maintained within narrow limits of constancy if all the resident and visiting cells are to live and carry out their respective functions properly.

This maintenance entails a very critical balance between entry and exit of fluids and also between intercellular and intravascular pressures. The uses to which teeth are put are such as to favour interruptions to the pulpal blood supply. This is particularly so if a traumatic occlusion exists, during orthodontic treatments and accompanying minor injuries.

Continuous partial or repeated minor interruptions of this vascular supply are followed rapidly by alteration in cellular metabolism and degenerative changes. Dystrophic calcification of the pulp, commonly called pulp stones and erroneously calcific degeneration, is frequently found in people undergoing orthodontic treatment or suffering from traumatic occlusion in varying degree.

Mechanical interruptions of blood supply of this nature are accompanied also by interference with lymphatic drainage so that, in addition to inadequate nutrient supply, there is also obstruction to the elimination of waste products which consequently increases the chances of degenerative changes occurring.

The site of degenerative changes in the pulp and their sequelae, dystrophic calcification, is significant. They occur with greater frequency and in most widespread fashion in the root canals where the volume of tissue fluid is least and its balance consequently more readily disturbed.

In the coronal pulp chamber these changes usually occur in isolated regions, their distribution being governed by the state of cellular activity obtaining in these areas at the time the disturbance occurred. It is characteristic of every organ that all cells are not actively functioning at the same time and those whose metabolism is disturbed while in maximum activity are more prone to degeneration than those disturbed while in the resting state.

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(b) *Atrophy.*

The causes of atrophy in general are two: hormonal influences and continued lack of adequate nutrition. The atrophy of the pulp which occurs with age is probably associated, at least in part, with the hormonal changes which occur at the time of the "adrenopause" (Albright), though the role of hormones in this regard has never received the attention it deserves.

This senile atrophy of the pulp has been explained by the gradual restriction of blood supply which results from the progressive narrowing of the apical foramina by cementum deposition. To the author this explanation appears inadequate.

With advancing age the volume of the pulp cavity becomes progressively smaller due to the continued deposition of dentine on its walls. This decreased volume must result in two things: firstly a decrease in the demand for blood and secondly a decrease in the number of cells which the lessened volume of tissue fluid is able to maintain. Such an atrophic pulp is generally described as manifesting an increase in fibres and a decrease in the number of cells. What really happens is a decrease in cells only, the fibres remaining. The apparent increase in fibres is more relative than absolute.

Other factors than age also bring about decreased nutrition and consequent atrophy and one of the chief of these is disturbance of normal interstitial pressures. The interchange of nutrient and energy producing materials between cells and tissue fluid is dependent on the operation of osmotic forces across plasma membranes. If these should be disturbed unduly the result will be either cellular inanition or intoxication with consequent atrophy, degeneration or both.

In most connective tissues variations in osmotic and hydrostatic pressures of tissue fluid are distributed over wide areas unless extreme as in inflammation. In the dental pulp, however, confined within unyielding walls, minor changes of this nature are felt much more readily by its cells.

Increase in volume of tissue fluid is normally part of the inflammatory reaction but there are probably many occasions upon which the factors producing this increase are induced by comparatively mild stimuli and do not progress to fully fledged inflammation.

In most tissues such effects would be transient and pass unnoticed; in the rigidly confined pulp, however, they are felt very soon. The exact nature of the stimuli which produce such changes in the dental pulp is a matter of conjecture. It is, however, a frequent observation that an increase in tissue fluid volume occurs fairly frequently in response to certain filling and lining materials and following certain pulp capping procedures. Only when the increase is extreme does it manifest itself clinically as pain.

Such things as lack of calcium, increased H-ion concentration, lack of oxygen and presence of metabolites such as lactic acid are known to bring about increased capillary permeability and consequently an increase in the quantity and alteration in the quality of tissue fluid. Whether one or more of these factors operate in the present instances or whether the effect is one of some drug or irritant directly on the capillary endothelium we do not yet know. Certainly there is no reason to regard as of no significance the appearance of vacuoles of fluid in pulps under various lining and filling materials.

From this brief discussion it can be seen that the determination of that fraction of the volume of pulp tissue which is occupied by tissue fluid is of great practical importance in the study of the transport of materials from blood to tissue cells. It is apparent also that, since this fluid is derived from blood plasma, in such a confined tissue its volume must exert a dominant influence on the volume of blood available for circulation through the pulpal vascular tree at any given moment.

It is apparent that the relationship between volume of circulating pulpal blood and pulpal tissue fluid must be a reciprocal one maintained within close limits in a confined tissue. An increase in volume of blood must be countered by decrease in tissue fluid and vice versa. This relationship must be of great physiological importance to pulp tissue. It must vary considerably during normal function and even more so during abnormal stress. The extent and effects of these variations are fertile grounds for study.

Active Changes — Inflammation.

Apart from these more passive changes the pulp does respond to some stimuli in an active manner by inflammation which may be either acute or chronic depending upon a variety of circumstances. In both acute and chronic inflammation there is an increase in local cell population; in acute inflammation increase in volume of extravascular fluid is considerable while in the chronic form it is slight. These facts are of great importance in the symptomatology and treatment of pulp inflammations.

(a) *Acute inflammation.*

Acute inflammation in other tissues is followed by repair and resolution if the irritant is removed; in the dental pulp, however, necrosis rapidly occurs and the reason for this is almost entirely the confined nature of that tissue.

The fixed volume of the pulp cavity cannot support the great increase in the visiting cell

population which accompanies such an inflammatory condition. This, however, is partly offset by local death of pulp cells and if this were the only factor involved the pulp would be able to recover.

The ability of a pulp to survive an inflammatory reaction of this nature is almost entirely dependent on its capacity to deal with the great increase in its fluid content. This capacity is in turn dependent on the nature of the blood supply and lymphatic drainage, the physical nature of the periapical tissues, the size and number of the apical foramina and the presence or absence of an opening into the oral cavity.

Until 1938 it was believed that necrosis following pulp inflammation was due to increased arterial pressures occluding the veins at the narrow apical foramina. Boling and Robinson[1] showed this assumption to be false and concluded from their *in vitro* experiments that such necrosis resulted from increased pressures of inflammatory exudate obstructing blood flow.

Boling and Robinson concluded that pulpal blood flows through a closed hydrostatic system in which arterial equals venous pressure. These conclusions have, so far, been generally accepted but they cannot be entirely correct for a decreasing pressure gradient must exist for the formation and maintenance of the pulpal tissue fluid. The difference between arteriolar and venular pressures is only slight, however, and their conclusion that apical venous obstruction does not occur as a result of increased arterial pressure seems justifiable.

These workers did, however, ignore the major effect which increased tissue fluid volume and increased protein content of that fluid must have directly upon the *cells* of the confined pulp.

In the author's opinion inflammatory pulp death is due to a combination of both the increased hydrostatic and osmotic pressures of the fluid content of the pulp which occurs during inflammation and the effect of these not only on the circulation of pulpal blood but also directly on the metabolism of the pulp cells.

There is also a strong possibility that these pressures in this tissue result in obstruction to lymphatic flow with consequent accumulation of metabolites, increase in H-ion concentration and partial anoxia. The effects of these on cell metabolism are at least of equal importance in causing pulp death as the possible circulatory stasis.

(b) *Chronic inflammation.*

In addition to a more moderate and less acute increase in cell population chronic inflammation is accompanied by a minimal amount of fluid exudation which takes place slowly over a considerable period of time. Pressure changes are therefore slight and intermittent.

These changes are not sufficient to cause widespread death of all cells but they are sufficient to interfere with the more complicated enzyme systems of specialised cells. In most tissues, therefore, chronic inflammation is typically characterised by degeneration of specialised cells and proliferation of more humble fibroblasts.

In the closed dental pulp proliferation of any extent is rendered impossible by the limits imposed on cell population by the available space and amount of tissue fluid. Degeneration of specialised cells, such as odontoblasts, proceeds but instead of proliferation of fibroblasts these gradually atrophy over a long period of time. In multirooted teeth particularly, this atrophic process may be extremely slow and one canal may become completely atrophic while others still maintain life.

Occasionally hyperplasia does develop in a closed pulp. When this occurs, however, the proliferative process is accompanied by enlargement of the pulp cavity through the activity of osteoclasts which resorb the hard dentine walls.

The process is also accompanied frequently by metaplasia and formation of bone-like material. This condition is known as "Pink Spot" or more correctly "Chronic Perforating Hyperplasia."

Many of these cases can be traced to an inflammatory origin but in many respects the condition has characteristics of a neoplasm. Once it has started it continues to progress even after removal of possible irritants and in some cases no inflammatory origin or irritating mechanism can be found.

It would appear that, under the influence of some environmental change of the nature of which we are in ignorance, there is a gene mutation induced in the pulp cells. This change in genetic structure causes the pulpal mesenchyme to take on some of the attributes of bone-forming mesenchyme.

There is formation of vascular granulation tissue with the presence of both osteoclasts and bone-forming cells. There is also a possibility that hormonal influences may play a part in the process and it would be of interest to know the effects of steroids on inflammatory pulp conditions.

Inflammatory reactions in a closed pulp are necessarily very different from those which follow after caries has made an opening to the oral cavity. Pulpitis, whether acute or chronic, in a closed pulp is sooner or later a threat to the life of that tissue. If an opening exists early in the process the pulp may survive a considerable degree of injury, manifest less pain on account of the absence of pressure

and the inflammation may then have some of the beneficial effects it has on other injured tissues.

It is fortunate that, owing to the nature of the common causative irritants, most inflammations of the pulp commence as chronic ones. If an opening is established before the tissue has sustained a great deal of damage there is release of pressure, subsidence of any pain, drainage of metabolites and autolytic products and the tissue may enter a reparative phase.

Such an open pulpitis may take either of two forms: chronic ulcerative or chronic hyperplastic. In the former destructive influences predominate while in the latter proliferative phenomena dominate the picture. In both cases the pulp remains vital though the prognosis of the ulcerative type is less favourable.

The factors which determine which of these two types of open pulpitis will occur are, in the main, two: (1) the nature and intensity of the irritant; (2) the capacity of the pulp cells for proliferation.

If the irritant is intense, destruction will predominate and ulcerative pulpitis will develop. In such cases the maintenance of the chronic state is also dependent upon the ability of the defence mechanism to deal with the continued irritation and maintain a satisfactory balance between attack and defence. Such a balance is influenced very considerably by the continued patency or otherwise of the opening. If this should become closed while the irritant persists an acute condition may rapidly follow.

The capacity of cells for proliferation and repair is of paramount importance in all matters pertaining to conservative pulp treatments. This capacity is dependent upon a variety of factors which, for brevity, we may call "the nature of the internal environment of the pulp" either at the time the opening occurred or when treatment commenced. As will be mentioned later, it is our present inability to assess accurately, by any known diagnostic methods, the nature of this state which makes conservative pulp therapy so unpredictable in its results.

The factors which determine the nature of the internal environment and thus the capacity of cells to proliferate, repair or to respond to treatment are many:

(1) The nutritional state of the cells.

(2) The degree of degeneration or damage which has occurred already.

(3) The nature of the blood supply and its ability to maintain the increased activity.

(4) The ability of defence mechanisms to deal with irritants present.

(5) The effects of age which are also related to hormonal influences, blood supply and size of apical foramina.

(6) Possible genetic influences.

With ulcerative pulpitis the picture is very similar to a chronic ulcer in other tissues. Hyperplastic pulpitis commences as the ulcerative type but owing to the mild nature of the irritant and the better internal state of the pulp there is proliferation of granulation tissue through the opening. This may or may not become epithelialised but if this does occur a partial healing of the pulp wound has taken place and the granulation tissue is replaced by a firm fibrous tissue through which are distributed areas of calcification.

The origin of such an epithelial covering is still debated. It is generally believed to develop from minute cell grafts of desquamated oral mucosa. Squamous epithelium has occasionally been demonstrated in normal pulp tissue but is uncommon.

It is interesting to note that recent investigations suggest a possibility of odontoblasts being of ectodermal origin arising from the neural crest. This has been proved to occur in certain amphibia; it has yet to be demonstrated in mammalia. If such proof does eventuate then this epithelial covering may be a form of metaplasia of these cells in response to the change in environment.

Diagnosis and Treatment.

The author's discussion of the diagnostic aspect is unfortunately not constructive but is offered in the hope that it will act as a stimulus to improve existing methods which he feels are almost if not entirely unsatisfactory.

It is my belief that symptoms of pain in the type of pulp conditions which have been discussed here are the expression of the pressure phenomena which exist within the diseased pulp. If this is so then neither the common thermal nor electrical methods of pulp testing give any more reliable indication of the nature of a pulpal pathological state than the ability of the nerves to conduct impulses.

Acute pulpitis needs no diagnostic aid; it is, however, not possible to hazard anything more than a good guess at the full nature and extent of a chronic pulp inflammation or an early degenerative lesion from symptoms of pain alone. The commonly used electrical pulp testers convey very little more of any real value. The passage of electrical stimuli bears little relation to the microscopic pictures of such pulps.

It is obviously of paramount importance to know the state of the tissue we are attempting to treat — what we have called "the internal

environmental state of the pulp" at the time treatment is commenced. It is our inability to determine the nature of this state by any accurate diagnostic measures, other than long clinical experience, that makes the success or failure of conservative pulp therapy such an unpredictable event. Such therapy must remain a "hit and miss" procedure until more accurate and scientific methods of pulp diagnosis are found.

In spite of our obvious diagnostic shortcomings it is apparent from the above discussion that treatment designed to restore a pulp to health will generally follow through certain well defined steps:

(1) Removal of the irritant factors.

(2) In closed pulps, release of pressure.

In some cases this may be achieved simply by withdrawal of the irritant; in others, mechanical opening may be required.

(3) Sealing of the wound with a bland non-irritating material, preferably with some therapeutic effect. Calcium hydroxide appears to have some such properties but its exact mode of action is unkown and its use therefore entirely empirical.

Several possibilities suggest themselves:

It may be that the material is simply bland and non-irritating in which case it is Nature alone that heals. It may be that its alkalinity is its chief virtue whereby it may precipitate protein and cause deposition of calcium or it may lower the H-ion concentration and thus decrease capillary permeability and reduce interstitial pressures. It may provide readily available calcium for initial repair or it may absorb water and thus reduce pressure.

Whatever its mode of action it should be known to us if we are to avoid more empiricism in this branch of dentistry and place it on a sound and scientific basis.

Only by improvement in diagnostic methods and good scientific investigation can we achieve real knowledge and success in this branch of healing. As long as empiricism remains predominant Dentistry will remain an art and not a science. The pathologists are doing their best; there is still a great need for good clinical research into problems such as these.

SUMMARY.

1. Problems of the more common types of pulp pathology are discussed.
2. Some fallacies in presently accepted opinions are pointed out and fresh opinions offered.
3. The inefficacy of present diagnostic measures and empiricism in treatment is stressed.
4. A plea is made for more research into clinical problems of diagnosis and treatment.

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1. Boling, L. R. and Robinson, H. B. G.—Vascular changes in the inflamed dental pulp: J.Dent.Res., 17:310 (Aug.) 1938.

The Buffer Systems in Human Saliva

*B. Lilienthal, B.D.S., B.Sc. (Syd.), D.Phil. (Oxon.)**

In view of the considerable evidence supporting Miller's chemico-parasitic theory of the aetiology of dental caries a few investigators have studied the buffer capacity of saliva to determine any differences in the acid-neutralising power of saliva from caries-free and caries-susceptible individuals. Only a few attempts have been made to analyse the buffer mechanisms in saliva and to determine the relative importance of each system. Wah Leung[1] showed that bicarbonate is the most important buffer substance between pH 6.8 and 7.2. His report was based on a study of the CO_2-combining capacity of the saliva from 11 subjects.

In a more extensive study of 61 subjects carried out in this Institute the relationship of bicarbonate to the buffer capacity was investigated for the pH range 7.0-5.0. This was done by comparing titration curves of saliva before and after removal of the bicarbonate-carbonate system by means of CO_2-free air at a pH value below 5.0. Bicarbonate was found to account for 50-80 per cent. of the buffer capacity of paraffin-activated saliva.

The remainder of the buffer capacity appears to be due to phosphate, because after dialysis of saliva no buffering was observed: dialysis at 4°C for 4 hr. against distilled water removed all the inorganic phosphate and 90 per cent. of the bicarbonate. Titration of the residual fluid, which contained the proteins and mucoid, showed that these substances do not possess any significant buffering properties.

A further study was made of the possible buffering action of salivary mucoid. Preparations of mucoid were made by the method described by Knox and Still[2] and potentiometric titration showed that such preparations exert no buffering action. The previous observation[2] of buffering action of mucoid was due probably to the sodium carbonate in which the mucoid was redissolved after precipitation and washing, because my study shows that

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when this carbonate was removed (as described above) titration of the mucoid solution, after readjustment of pH with barium hydroxide, gave similar results to those obtained with water. The lack of buffering power was also shown by the fact that the addition of precipitated mucoid to solutions of HCl failed to change the pH over a period of several days.

Stralfors[3] indicated that "mucinous plaques" have a greater buffer capacity than saliva on a weight basis and showed a similarity, both qualitatively and quantitatively, between the buffer curves for "plaque" and for salivary sediment. This sediment consists mainly of bacteria. It is obtained from saliva by centrifugation and, when washed and resuspended in water, the buffering curve obtained with HCl was found to be due to bacteria and adsorbed bicarbonate but not to adsorbed phosphate. Plaque material gives a titration curve none of which is due to adsorbed bicarbonate.

These and other studies on the buffer systems present in saliva and their importance in the buffering action of the so-called "mucinous plaque" will be reported fully elsewhere.

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Dental Materials

*Current Notes No. (23)**

Widening Interest in Dental Standards.

Not only has there been increasing activity in various countries toward the establishment of standards for dental materials and equipment, but interest has been stimulated on an international plane as well. This resolution from the Dental Materials Section of the International Dental Congress held in London last year was approved by Congress:

That this Section on Dental Materials of the XIth International Dental Congress, having regard to the increasing need for basic research in the science of dental materials and their standardisation, are in favour of a much wider degree of international exchange and co-operation in these subjects and recommend that steps be taken to explore the possibility of establishing an international bureau in these subjects.

The resolution has been implemented through the Research Commission of the Federation Dentaire Internationale and a Sub-Committee on Standardisation of Dental materials has been organised with representatives from Australia, Europe and the U.S.A.

In Great Britain over the past two years committees have been at work on several standards for dental goods. The British Standards Institution is co-ordinating this work through its Dental Industry Standards Committee which has appointed three technical committees to deal respectively with acrylic resins, dental tools and laboratory equipment, and conservation materials. Satisfactory progress is being made in all these fields and it is anticipated that draft standards for some materials will be issued for public critical review in the near future. There are, of course, other B.S.I. committees which prepare specifications of direct or indirect interest to dentists. A recent example of this is the draft British Standard for the dimensions of dental and occlusal x-ray films, arising from the work of a committee chiefly concerned with other aspects of the photographic industry.

The South African Bureau of Standards has also undertaken the standardisation of dental products; they are particularly interested in sythetic resin teeth at the moment.

The pioneering work in the U.S.A. is being maintained. The most recent development published in a revision of the American Dental Association Specification No. 12 for Denture Base Resin which now indicates the self-curing type of resin. Improvements have been made in several sections of the specification as a result of experience gained over the twelve years the previous revision had been in effect.

In our own country the Standards Association of Australia has issued eight dental standards, the most recent being for artificial stone and silicate cement. Those materials for which standards are approaching the final stages of preparation include inlay and denture casting golds and inlay wax. Wrought golds, denture base resin, sticky wax and hydrocolloidal impression materials, both agar and alginate types, are materials for which draft standards are almost ready for public critical review.

As explained in Current Notes No. 20, the Standards Association has ventured into the field of biological products. Local anaesthetic solutions are of immediate concern and a Sub-Committee has been appointed to consider these. Instruments, burs, x-ray films and other dental products not usually classed as "materials" will no doubt be considered later and if any dentist cares to suggest to the Dental Association Standards Committee a class of instrument or other dental accessory that he considers is in urgent need of standardisation, his comments would be appreciated as a guide to further action.

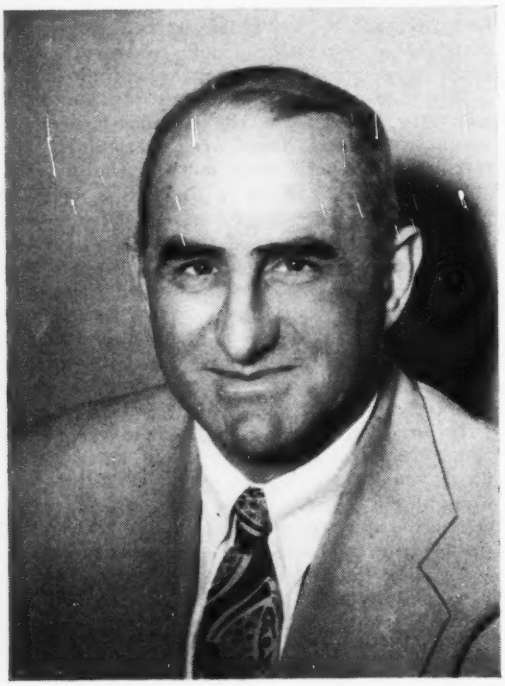
*Contribution from the Commonwealth Bureau of Dental Standards.

Editorial

A.D.A. Sponsors Visit by Professor Basil Bibby

The visit of Dr. Basil Bibby to this country is a significant indication of the realisation of the basic scientific and biological approach to the practice of dentistry.

The dawning of the era of oral medicine, its appearance in Australia not without many difficulties as the profession well knows, will encompass and overshadow the mechanical approach to the establishment and the maintenance of oral health which has so predominantly influenced dentistry all over the world.



Professor Basil Bibby.

The application of the techniques of modern science to the fundamental problems of dental caries, periodontal disease, and developmental abnormalities—investigations with a biological basis—have shown that if treatment and prevention are to be rational and successful, this knowledge is essential.

Dr. Bibby has come by A.D.A. invitation from New Zealand, where he is spending six months under the auspices of the Fulbright Scheme. As Professor of Dentistry at Rochester University and as Director of the Eastman Clinic, he is as it were, representative of this changing approach, this new concept, the antithesis of the mechanical outlook of a primitive dentistry. He is well and widely known as a scholar, a research worker and administrator of the highest standing.

This is the first occasion that the Fulbright scheme has brought to Australia a leader in dental thought from the United States, and it is to be hoped that this is the first of many. The value of this visit, brief as it must be, affords the opportunity for discussion of common problems—the solutions of some are even now awaited in this country—and provides a stimulus for the profession, the Faculty and those occupied in dental research.

Furthemore, the profession benefits indirectly by a favourable public reaction to the visit of such an authority as Professor Basil Bibby.

A further indication of progress which can be expected is given in the remarks of Professor A. J. Arnott, Dean of the Dental Faculty, when he outlined his future programme of building a Dental Clinic devoted to clinical research in the prevention of dental disease.

These trends in dentistry are the answer to the promotion and maintenance of the public dental health. As has been pointed out previously and even more appropriately at this time, research, education and prevention are the solution to the dental problems of the community, not the provision of partly trained ancillary personnel as some would have us believe.

Honorary Editor: N. D. MARTIN, M.D.S.

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News and Notes

Australian Dental Association Standards Committee

LIST OF CERTIFIED DENTAL MATERIALS

12th October, 1953

The products listed below are certified by their manufacturers to comply with the requirements of the respective Australian Standards. Before including a product in the list the Standards Committee of the Association must be satisfied that it does in fact meet the requirements and that there is sufficient control in its production to ensure that the quality is maintained. Periodical check testing on samples obtained on the open market confirms whether this is so.

It will be appreciated that this accreditation programme has been organised in the interests of the practitioner and, if he is to give the best service to his patient and is to encourage the supply of reliable materials, he should make sure that the product he chooses is one of those listed. He will see from the list that he is still offered a wide choice although, in fairness to the manufacturers and distributors concerned, it should be pointed out that there has been insufficient time to receive and examine all potential applications for accreditation of products of the more recent Standards — No. T8 for Silicate Cement, for example.

Applications are also pending for the intermediate Standards T4 to T7 and, if accepted, will be included in subsequent lists which are to be published twice a year in future. If there is any doubt about a particular product members of the profession may obtain information from the A.D.A. Standards Committee or direct from the Commonwealth Bureau of Dental Standards.

When a manufacturer or distributor conscientiously supplies a product to a standard recognised as the hall-mark of good quality it is only fair that the dentist should give preference to such a product when ordering, for in so doing he will stimulate further improvements in quality and reliability, not only of the materials listed, but of those for which standards are in preparation.

CERTIFIED MERCURIES (A.D.S. No. T1):—

Mercury.	*Manufacturer or Distributor.*
Ash Chemically Pure Mercury	The Amalgamated Dental (Aust.) Pty. Ltd.
Bosch Mercury	Bosch Naylor Pty. Ltd.
Glover & Goode Dental Mercury	Glover & Goode Pty. Ltd.
May & Baker Mercury	May & Baker (Aust.) Pty. Ltd.

CERTIFIED AMALGAM ALLOYS (A.D.S. No. T2):—

Amalgam Alloy.	*Manufacturer or Distributor.*
Baker's Aristaloy	Glover & Goode Pty. Ltd.
Bosch Alloy	Bosch Naylor Pty. Ltd.
Bosch 70% Alloy	Bosch Naylor Pty. Ltd.
Crompton Alloy (67%)	Crompton Dental Products.
Crompton 70% Alloy	Crompton Dental Products.
F. & G. 70% Alloy	Felton Grimwade Dental Co. Pty. Ltd.
G. & G. 70% Alloy	Glover & Goode Pty. Ltd.
G. & G. Quick Setting Alloy (Standardised)	Glover & Goode Pty. Ltd.
Jendent 68% Alloy	John T. Jennings Pty. Ltd.
K. & L. Alloy	Kemp & Liddell Pty. Ltd.
Premodent	Milne Brown & Co. Ltd.
Six Eighty Dental Alloy	Garrett, Davidson & Matthey Pty. Ltd.
Solila Alloy Quick Mixing	The Amalgamated Dental (Aust.) Pty. Ltd.
Solila Alloy Standard Formula	The Amalgamated Dental (Aust.) Pty. Ltd.
True Dentalloy	The S. S. White Co. of Australia Pty. Ltd.

CERTIFIED ZINC PHOSPHATE CEMENTS (A.D.S. No. T3):—

Cement.	*Manufacturer or Distributor.*
Dalton's Zinc Cement	The Dalton Chemical Co.
De Trey's Cement Improved	The Amalgamated Dental (Aust.) Pty. Ltd.
S.S.W. Zinc Cement Improved	The S. S. White Co. of Australia Pty. Ltd.

CERTIFIED SILICATE CEMENTS (A.D.S. No. T8):—

Cement.	*Manufacturer or Distributor.*
S. S. White Filling Porcelain Improved	The S. S. White Co. of Australia Pty. Ltd.

University of Sydney, Post-Graduate Committee in Dental Science

Members of the profession are notified that the following courses of instruction will be held during 1954.

As the number of members of each post-graduate class is limited, with the exception of the course in Public Health Dentistry, early application is essential.

Any dentist desirous of attending a course or courses is requested to contact the Secretary, Post-Graduate Committee in Dental Science, Dental Hospital of Sydney, Chalmers Street, Sydney.

A. J. ARNOTT,
Chairman.

Course No. 36: *Periodontia.*

1st March, 1954, to 5th March, 1954.
Enrolment limit—10.
Clinicians: Dr. D. J. Martin and Mr. G. T. Hutchinson, B.D.S., F.D.S.R.C.S.

A complete course in Periodontia giving the etiology, diagnosis and treatment. The course will largely consist of practical work.

Course No. 37: *General Anaesthesia with Special Reference to Treatments in the Practice of Pedodontia.*

8th March, 1954, to 12th March, 1954.
Enrolment limit—15.
Clinicians: Dr. A. P. Balthasar and Mr. R. Harris, M.D.S.

The most recent advances in anaesthetic agents and techniques will be demonstrated, with special reference to their dental application. The use of relaxants in conjunction with intravenous pentothal will be included. Premedication analgesic agents, and the most satisfactory methods of using general anaesthesia in the treatment of children will be dealt with from the viewpoint of the general practitioner. A feature of the course will be the opportunity for members to obtain practical instruction.

Course No. 38: *Crown and Bridge Work.*

24th May, 1954, to 28th May, 1954.
Enrolment limit—10.
Clinicians: Mr. N. W. Kestel, M.D.S. and Mr. K. H. Caisley, B.D.S.

The course will cover both the theoretical and practical aspects of the restoration by fixed bridgework of short-span edentulous spaces and the restoration of the various conditions of fractured anterior teeth.

Course No. 39: *Partial Denture Construction.*

31st May, 1954, to 4th June, 1954.
Enrolment limit—12.
Clinicians: Dr. J. H. Wilson and Mr. K. P. Mackinnon, M.D.S.

The course will consist of illustrated lectures, clinical methods and technological demonstrations, upon the following aspects of the subject: partial denture prosthesis as a preventive health service, the biological, physiological and pathological factors involved, diagnosis, and prognosis for partial dentures, impressions, occlusion, retention, design of plastic and metal dentures in relation to periodontal tissue, technology and the scientific use of various materials used in partial denture construction.

Course No. 40: *Short Course in Orthodontics.*

9th August, 1954, to 13th August, 1954.
Enrolment limit—15.
Clinicians: Dr. W. N. Benson and Mr. R. Y. Norton, M.D.S.

Lectures and films dealing with the following subjects will be given: (i) normal occlusion, (ii) malocclusion, (iii) methods of case analysis and diagnosis, (iv) aetiology of malocclusion, (v) prevention of malocclusion, (vi) brief review of modern methods of treatment and discussion of problems to meet the increasing demand for orthodontic treatment. Demonstrations and table clinics covering the following subjects will also be given: (i) record taking for case analysis including cephalometric radiograph, (ii) observation of patients for case analysis, (iii) construction of simple space retainers, bite planes, plates for simple movements, etc. The object of the course is to assist the general practitioner to understand the problem of malocclusion in order to render treatment in selected cases.

Course No. 41: *Preventive Dentistry.*

16th August, 1954, to 20th August, 1954.
Enrolment limit—12.
Clinicians: Mr. N. D. Martin, M.D.S. and Dr. H. R. Sullivan.

All modern caries control techniques will be described and evaluated. Where necessary these techniques will be demonstrated. These will include: (i) Topical application of fluorides, (ii) topical application with reference to impregnation techniques of zinc ferrocyanide and silver nitrate, (iii) dentifrices and mouthwashes: ammonium, penicillin, urea and fluoride and chlorophyll, (iv) use of low carbohydrate diets with actual diet plans for the treatment of rampant caries in patients of all ages, (v) refined and natural sugars and their effects on caries susceptibility, (vi) tests for caries susceptibility including lactobacillus estimations in saliva for use with low carbohydrate dietary control. Chemical susceptibility tests will also be demonstrated, (vii) the use of water fluoridation for partial control of caries will be studied as a public health measure. Fluorides as dietary supplements will also be discussed.

Here is an essentially practical application of all the findings of modern dental research and dealing specially with caries control measures which may be utilized in dental practice.

Course No. 42: *Full Denture Construction.*

23rd August, 1954, to 27th August, 1954.
Enrolment limit—10.
Clinicians: Dr. C. H. Graham and Dr. A. G. Rowell.

This course will cover the clinical and laboratory procedures associated with recent advances in full denture construction. Lectures and clinical demonstrations will provide instruction on dental materials, impression techniques, methods of recording jaw relationships, arrangements of artificial teeth with emphasis on aesthetics and phonetics, prosthetic malocclusion and edentulous anomalies with their appropriate treatment.

Course No. 43: *Oral Surgery.*

30th August, 1954, to 3rd September, 1954.
Enrolment limit—15.
Clinicians: Professor A. J. Arnott, Dr. H. R. Kemp, Mr. C. H. Ritchie, B.D.S. and Miss N. F. Cordaiy, B.D.S.

The course will include a review of the fundamentals of surgery together with diagnosis and treatment planning clinics. Instruction will be given in regional anaesthesia and the surgical treatment of conditions which confront the general practitioner. The feature of the course will be the opportunity for members to obtain practical instruction.

Course No. 44: *Inlays.*

8th November, 1954, to 12th November, 1954.
Enrolment limit—12.

Clinicians: Mr. W. A. Grainger, M.D.S., and Dr. E. H. Bastian.

The course will comprise instruction on principles of inlay cavity preparation, advanced design of preparations for special purposes, pinlays, pinledge, three-quarter veneers and full cast crowns. Hydrocolloid and other indirect impression techniques, construction of dies and casts for cases involving multiple restorations, vacuum investing and casting techniques will be included. Instruction will also be given on the handling of waxes, investments and selection of gold alloys.

Course No. 45: *Public Health Dentistry.*

8th November, 1954, to 19th November, 1954.

Lecturers: Dr. H. G. Lancaster, Dr. F. W. Clements, Dr. H. R. Sullivan and Mr. R. Harris, M.D.S.

The course will consist of:—

(a) **Statistics:**

Description of a survey.
Description of a population—such as height, weights, caries incidence, haemoglobin values, tooth measurements, etc.
Variability (standard deviation and standard error of a mean).
Tabulation (construction of tables).
Graphical methods.
Tests of significance (plus "t" test, etc.).
Analysis of variance.
Planning of experiments.
Punch cards.
Further statistical techniques: Chi squared and correlation.
Practical tutorials on above subjects.

(b) **Public Health Dentistry:**

Review of existing public health dental services.
Dental programmes designed for specific purposes and age groups.
Evaluation of dental programmes.
Practical dental surveys.
Child management and study of a child health centre.
Dental health education projects.
Problems of pedodontics related to public health measures.

Course No. 46: *Orthodontics.*

Twelve months commencing 4th February, 1955, each Friday morning.
Enrolment limit—8.

Clinicians: Dr. W. N. Benson and Mr. R. Y. Norton, M.D.S.

The course will include (i) series of lectures covering the field of Orthodontics, (ii) instruction in the technique of band formation, and appliance design, (iii) practical case analysis and diagnosis, (iv) treatment of selected cases of malocclusion, (v) observations of cases under treatment or cases of special interest that may present.

First Meeting of the Organising Committee of the XII International Odonto-Stomatologic Congress

The first meeting of the Organising Committee of the XII International Odonto-Stomatologic Congress was held in Rome on March 19th in accordance with the principle of 5 yearly meetings laid down in 1900 with the foundation of the F.D.I.—it was decided at the Committee meeting that the Congress would be held in the Italian Capital in 1957. (The last took place in London last summer.)

As far as the fixing of the date is concerned the Committee, generally speaking, has attempted to coincide this international reunion as far as possible with the normal holiday period, that is between the end of August and the first week of September.

Prof. Giovanni Corradi has been appointed General Secretary of the Congress.

The following have been asked to be responsible for the different Committees set up to cover the organisation of the fortnight which approximately 5,000 active members, their relations and exhibitors will be spending in Italy.

Scientific Committee:—Chairman: Prof. De Vecchis. Vice Chairman: Prof. Benagiano.

Financial Committee:—Chairman: Dr. E. Ricci.

Press Propaganda, Publicity and Programmes Committee:—Chairman: Dr. N. L. Calarese.

Clinic Demonstrations Committee:—Chairman: Prof. Marziani.

Industrial Exhibition and Dental Trade Committees:—Chairman: Dr. C. Prandi.

Social Dentistry Committee:—Chairman: Prof. Bergamini.

Cinema and Television Committee:—Chairman: Dr. A. K. Ovadia.

Entertainment and Tourist Committee:—Chairman: Dr. Carli.

Printing of Congress Proceedings:—Chairman: Prof. U. Saraval.

Further, a Wives' Committee will be set up.

After the annual administrative meeting of the F.D.I. which will take place this year at Oslo (26th July-2nd August) the organising Committee will commence issuing a 6-monthly bulletin in 1954-55, quarterly in 1956, monthly in 1957 to keep.

Official languages of the Congress will be English, French, German, Italian, Spanish.

Indonesian Dental Delegation Visits Sydney

A delegation of Indonesian Dental Officers, who recently visited New Zealand to study the Dental Health Scheme operating there, were taken on an inspection of the Dental School by Professor A. J. Arnott when they arrived in Sydney.

The delegation was greatly impressed by the organisation of the Dental School and facilities for treatment provided by the Dental Hospital.

The members of the delegation were as follows:

Dr. Suria Sumantri, Principal Dental Officer, Province of West Java, in charge of Dental Health.

Dr. G. Rizali Noor, Principal Dental Officer, Ministry of Health, Division of Dental Health, in charge of School Dental Service; also Lecturer in Preventive Dentistry School for Dental Nurses, and First Secretary, Indonesian Dental Association.

Dr. Tan Hong Biauw, Public Dental Officer, Central Hospital, Djakarta, and Deputy Director of School for Dental Nurses.

Dr. R. Soejono, Principal Dental Officer, Province of Mid-Java.

Tasmanian School Dental Service Advises Vacancies in 1954

The Australian Dental Association has been advised by the Director of Public Health, Hobart, Tasmania, that there will be a number of vacancies in the Tasmanian School Dental Service early in 1954.

It is anticipated that one vacancy will be occurring at a Static School Dental Clinic at Queenstown and three vacancies in Mobile Dental Clinics in various country areas. Commencing salary at present is approximately £1,440, plus a travelling allowance if attached to Mobile Clinics.

Further particulars can be obtained from the Australian Dental Association, 135 Macquarie Street, Sydney, or by letter addressed to the Director-General of Medical Services, Division of Public Health, Maternal and Child Health, Hobart, Tasmania.

Obituary

Edmond Charles Gates, 1874-1953

Sydney lost one of its pioneer dental specialists in the passing on Thursday, 5th November, 1953, at Cronulla, of Dr. Edmond C. Gates at the age of 79 years.

Dr. Gates was born in 1874 at Jindalee, his father being on the land in that area. He proceeded to Northwestern University, Chicago, and graduated there in 1897. Returning to Australia, Dr. Gates commenced general practice at Burwood, then later transferred to Culwalla Chambers in Sydney where in 1924 he commenced specialist practice in Orthodontics.

Dr. Gates was appointed lecturer in Orthodontics at Sydney University in 1922, which post he held until his retirement in 1943. Throughout his long career, Dr. Gates inspired many Sydney graduates to interest themselves in Orthodontics and his kindly encouragement did much to establish the practice of Orthodontics in this country.

Dr. Gates served on many committees and societies during his lifetime, being at one time President of the Society of Dental Science and an early President of the Australian Society of Orthodontists. It is fitting that in his later years Dr. Gates was elected to honorary membership in this Society.

Dr. Gates is survived by his wife and six children.

A.D.A.-B.M.A. Cricket Shield

The Annual Doctors vs. Dentists Cricket Match for 1954 to be played for the A.D.A.-B.M.A. Cricket Shield has been set down for the Sydney Cricket Ground No. 1 on Wednesday, 20th January, 1954, at 10.30 a.m.

This match is always a popular event and a large attendance is confidently expected.

Members of the Association desirous of attending luncheon or afternoon tea are requested to contact the Secretary of the Association, 135 Macquarie Street, Sydney.

Northern Suburbs Dental Group

The Annual Sports Day of this Group was held at the Killara Golf Club on Thursday, 17th September, 1953: The results of the events were as follows:

GOLF:

Founders Cup and President's Trophy:
Winner: P. J. Anderson, 2 up.
Runner-up: L. Noone, square.

4-Ball Best Ball:
Winners: P. J. Hooton and A. S. Burgess, 6 up.
Runners-up: S. H. Wayland and S. G. Butt, 6 up.

1st Nine:
R. Dennett.

2nd Nine:
K. Binns.

Long Drive:
A. Kyd.

Blue Mountains Division

The Annual Sports Day of the Blue Mountains Division of the Australian Dental Association, New South Wales Branch, was held at the Leura Golf Club and the Katoomba Bowling Club on Friday, 2nd October, 1953. A most enjoyable day was had by all attending, although nominations were not quite up to expectations.

The results of the events were as follows:

GOLF:

4 *Ball v. Par*:

Winners: S. L. Jackson and W. B. Gray, 4 up.

Runners-up: L. Keyte and S. H. Wayland. E. F. Hewlett and J. Cordaiy.

Best Scratch Score:

L. Keyte and S. H. Wayland, 8 down.

1*st Nine*:

R. Watson and R. Dennett, 2 up.

2*nd Nine*:

E. F. Hewlett and J. Cordaiy, 3 up.

Long Drive:

W. Hill.

Putting Competition:

R. Hatter.

BOWLS:

Winners: V. Slocombe, S. Fox, F. Wakely, N. Macqueen.

Runners-up: A. Wells, T. Emanuel, F. Thearle, F. Clarke.

Association Activities

Australian Dental Association (New South Wales Branch)

General Meetings.

October General Meeting.

The October General Meeting of the Association was the occasion of a further conjoint address to members in the form of a symposium entitled "The Preservation of the Pulp Involved Tooth."

Dr. A. G. Rowell, in chairing the symposium, introduced the subject and Dr. L. E. McDermott, Dr. W. D. Suthers and Dr. J. S. Hill elaborated on various aspects.

This form of lecture has proved most acceptable to members and resulted in much discussion.

Executive Report.

Fact-Finding Committee.

Since the last issue of *The Dental Journal of Australia*, an indication has been received by the Executive that the report of the Chairman of the Fact-Finding Committee has been forwarded to the Minister for Health, New South Wales, for his consideration. Accordingly, it would be competent for the Executive of the Association to advise members further on this matter as soon as possible by circular or newsletter.

The general situation in regard to proposed legislative changes is being closely watched by the Executive of the Association.

Industrial Matters.

It has been noted that the Industrial Commission, New South Wales, has taken action of its own volition, subsequent upon the judgment of the Commonwealth Arbitration Court to discontinue quarterly adjustments to wages set out in the various State Awards. Consequently, salaries payable under the various Awards for dental employees remain static as from the first complete pay period in August, 1953. Any changes will be duly notified to members by circular.

Current legislation before the New South Wales Legislative Assembly concerning such matters as compulsory membership of unions, right of entry, and long service leave is being closely watched by the Association. Subsequent to deliberations by the Assembly on these matters, the Association will circulate members as to the impact of any amendment to existing industrial legislation upon dental practice.

Suburban Dental Organisations Liaison Committee.

Subsequent to an expression of approval from all suburban dental organisations, the Executive of the Association will proceed to establish a Suburban Dental Organisations Liaison Committee. It is felt that this will enable closer liaison between the Executive of the Association and the Suburban Dental Groups in the consideration of problems affecting the profession and the Association.

Repatriation Dental Treatment.

It is noted that long negotiations by the Federal Office of the Association with the Repatriation Commission have resulted in the Commission instituting its Local Repatriation Dental Officers' Scheme. Advertisements calling for applications for appointment as Local Repatriation Dental Officers appeared in the Sydney press on Saturday, 17th October, and the substance of such advertisements has been conveyed to members by Newsletter.

Additions to the Hardwick Memorial Library.

The following books have been added to the Hardwick Memorial Library:

Problems in Dental Local Anaesthesia, by Dr. Mendel Nevin.

Report of the United Kingdom Mission concerning the Fluoridation of Domestic Water Supplies in North America as a Means of Controlling Dental Caries, 1953.

Dental Health Education Material.

Members are advised that further supplies have been obtained of various dental health education material which was for some short period exhausted due to extensive orders. A further booklet on Preventive Dentistry and the use of x-rays, entitled "How to Save Your Teeth" is now available in quantity free of cost.

Existing orders will be given priority and completed as soon as possible.

Annual Meeting of the Association and Election of Executive.

The attention of members is again drawn to the Annual Report and Balance Sheet, in which a comprehensive report of the Association's activities throughout the past year has been set out.

This Annual Report will be before members at the Annual General Meeting of the Association on Tuesday, 24th November, 1953, on which date the Executive of the Association for the ensuing year will be announced subsequent to ballot.

MEMBERSHIP.

New Members.

Campbell, Alan D., B.D.S., D.D.S.; Daley, John Francis, B.D.S.; Graham, Anthony Hunter, B.D.S.; Sanders, William Frank, B.D.S.

Resumption of Membership.

Mr. K. G. Lowry; Mr. A. A. Melocco.

New Books and Publications

PHYSIOLOGY FOR DENTAL STUDENTS, by D. J. Anderson, London, 1952, Edward Arnold & Co. (344 pp., 141 illus.). Price 30s. (sterling). *Our copy by courtesy of the publishers.*

The author of this text is to be congratulated on the selection of his material and its presentation.

The text is easy to read and the illustrations and diagrams are well chosen to assist in the task of explanation.

The author still adheres to the older definition of complemental air, whereas American text books have drawn local usage over to their own way of expression.

The dental student will find the book of use as another presentation of any subject matter common to the general course in Physiology I.

The book is well printed on good paper.

—*W. J. Lawrence.*

Classified Advertisements

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DIVISION OF DENTAL SERVICES, DEPARTMENT OF PUBLIC HEALTH

Salary (Male), £1,064 p.a., range £1,359 p.a.; (Female), £851 p.a., range £1,087 p.a. Commencing rate according to qualifications and experience. Allowance of £17/10/- per fortnight and rail and other travelling expenses paid when employed in country districts. Duties consist of work in schools and/or State and Mental Hospitals. Applicants must be Registered Dentists.

Apply Public Service Board, 19 O'Connell Street, Sydney, by 4th January, 1954. For information 'phone BL 1779.

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Applicants must have University degree and be available for duty commencing on 14th January, 1954.

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Applications stating age, qualifications, experience and enclosing copies of references or names of referees to be forwarded to the Secretary before 12th December.

HONORARY DENTIST

Applications are invited for the position of Honorary Dentist (female) at the Rachel Forster Hospital for Women and Children, Pitt Street, Redfern. Honorarium £3/3/- per session, maximum of two (2) sessions per week. Applications, together with copies of testimonials, to be in the hands of the undersigned not later than 14th January, 1954.

(DR.) MARY C. PUCKEY,
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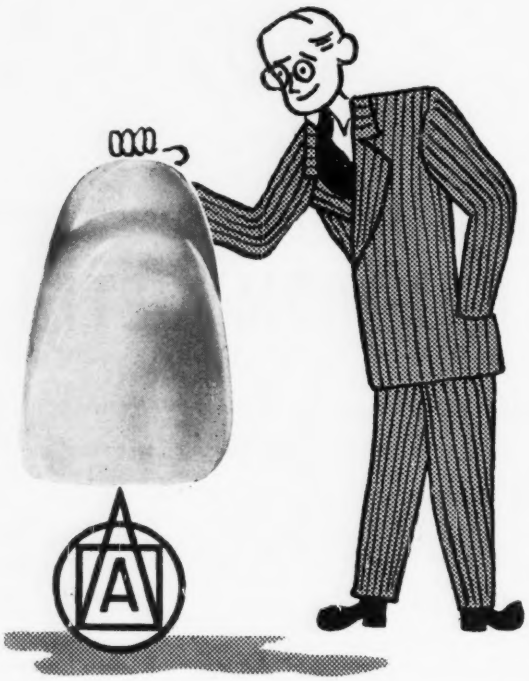

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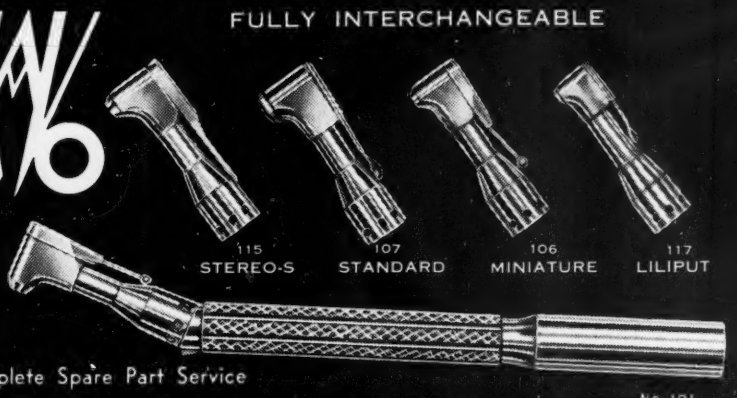

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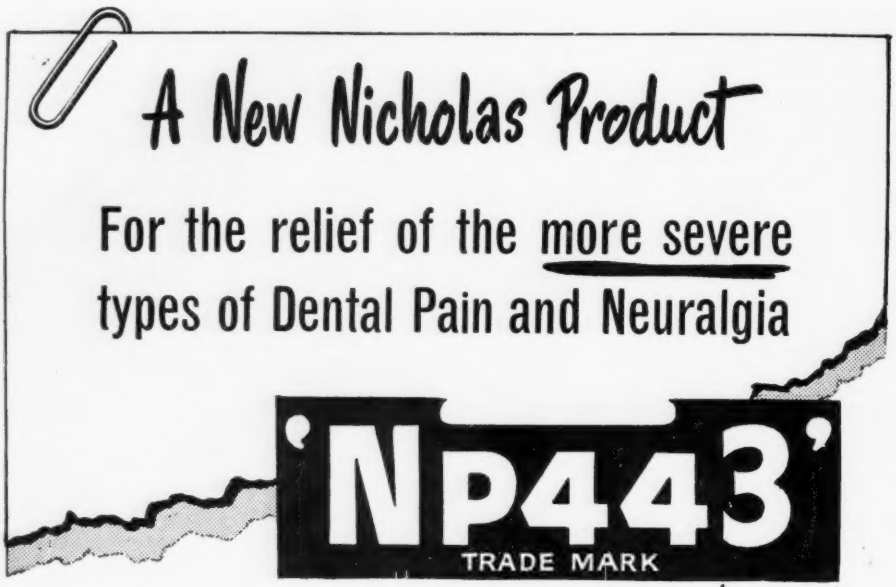

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"When barbiturates are combined with analgesic drugs such as the salicylates, they render the analgesia more effective"

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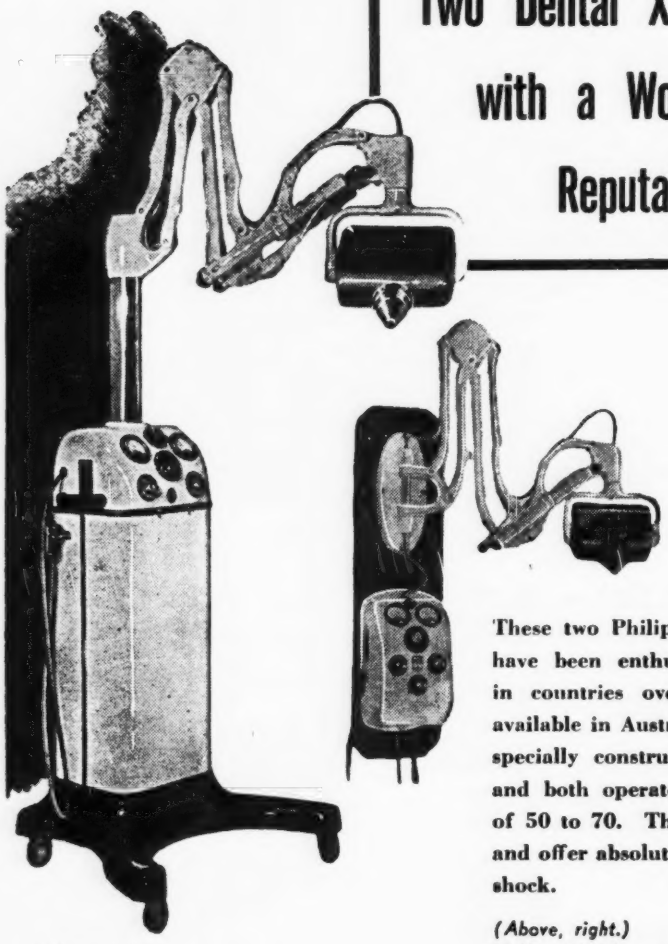

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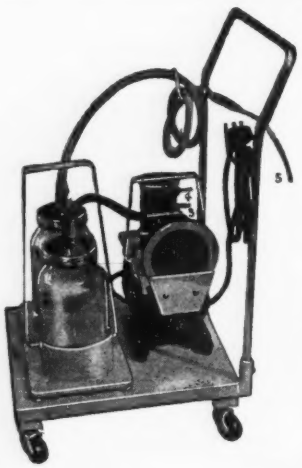

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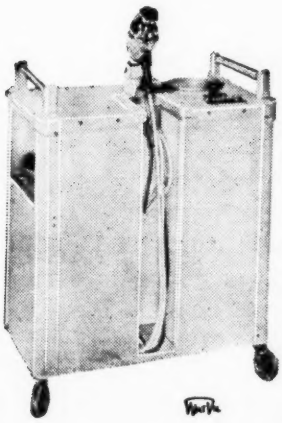

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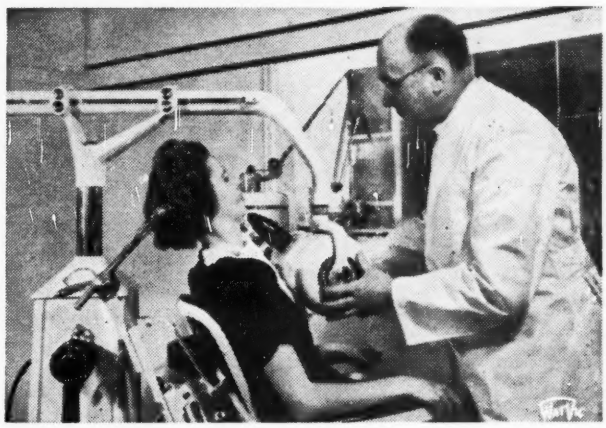

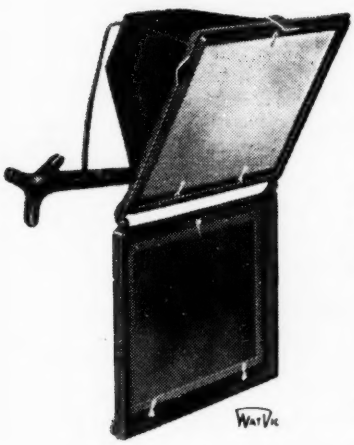

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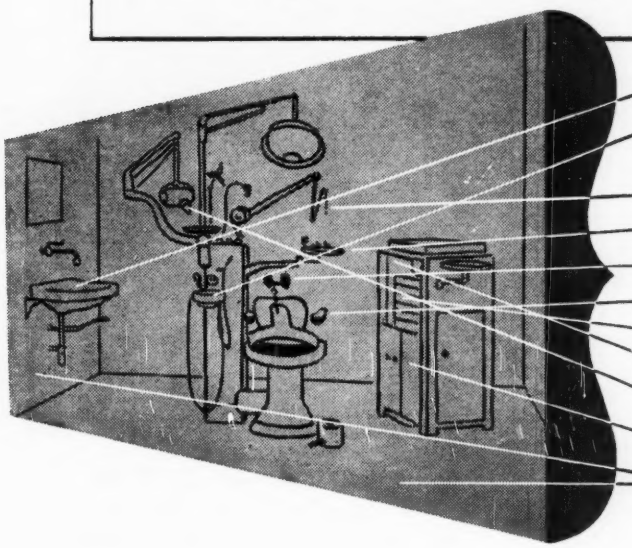

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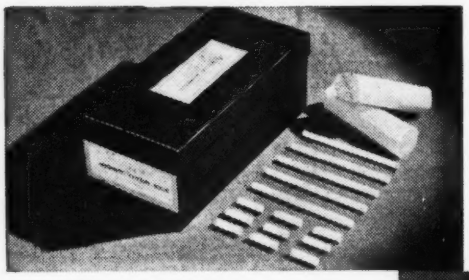

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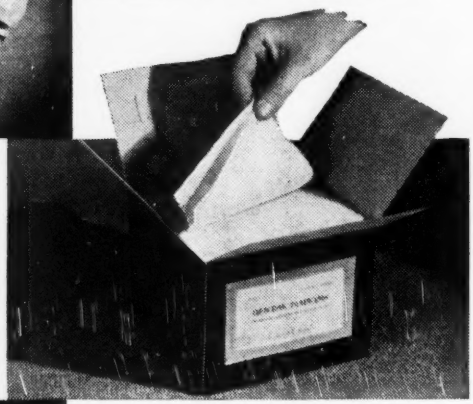

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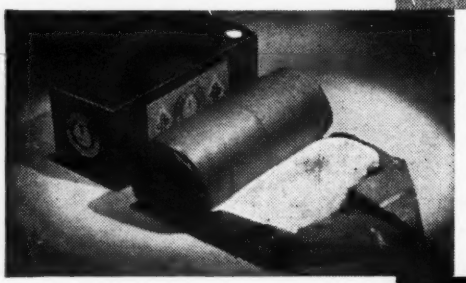

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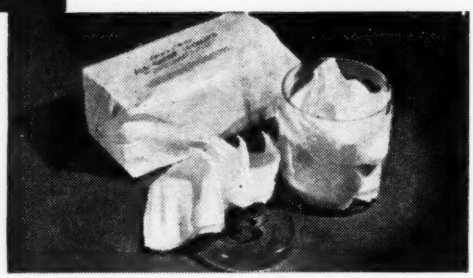

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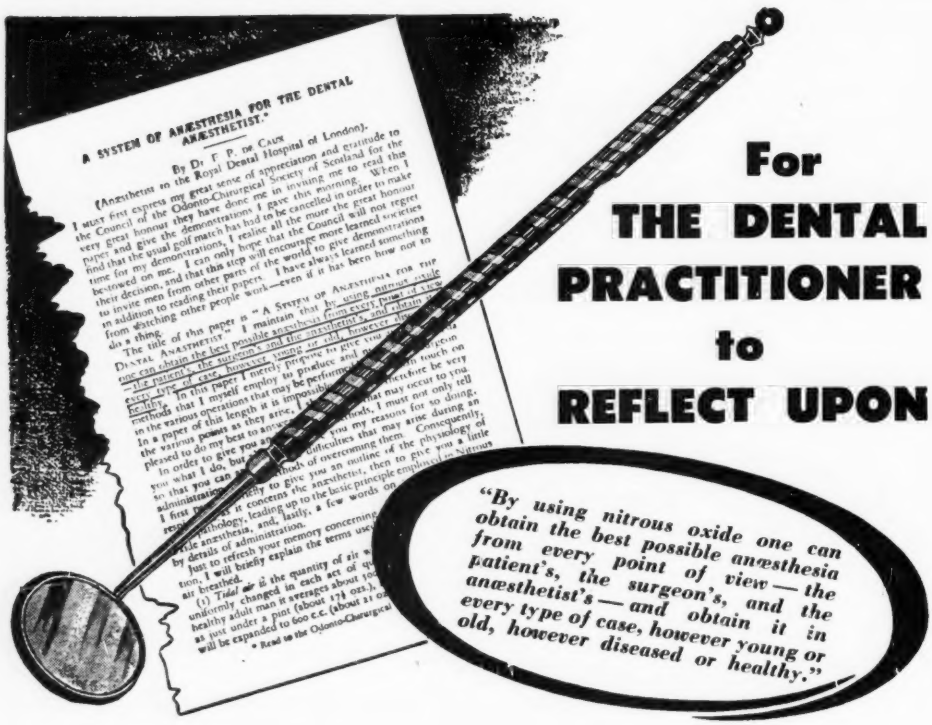
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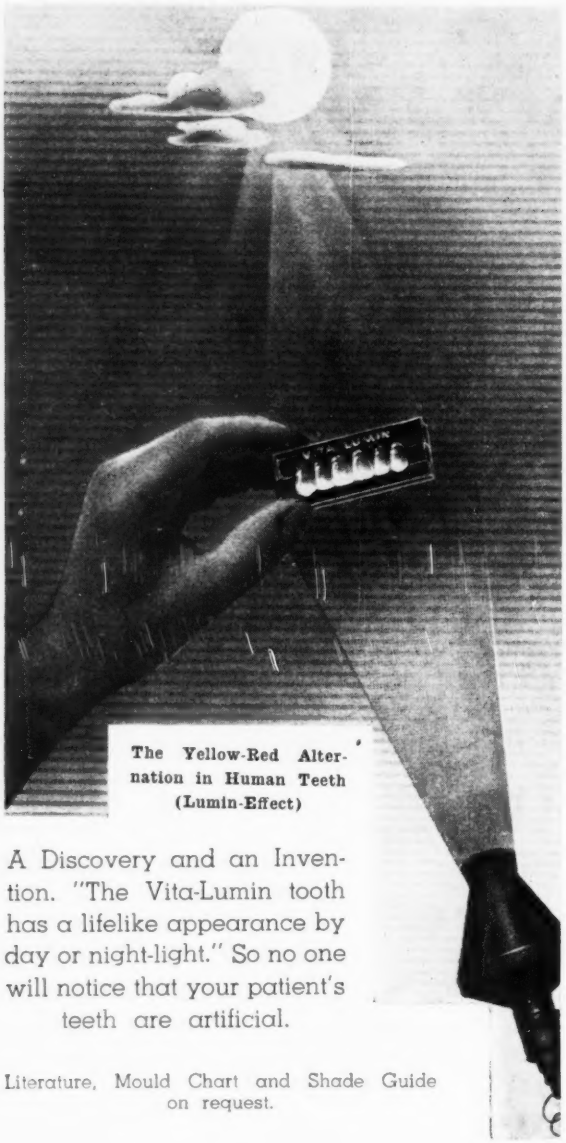

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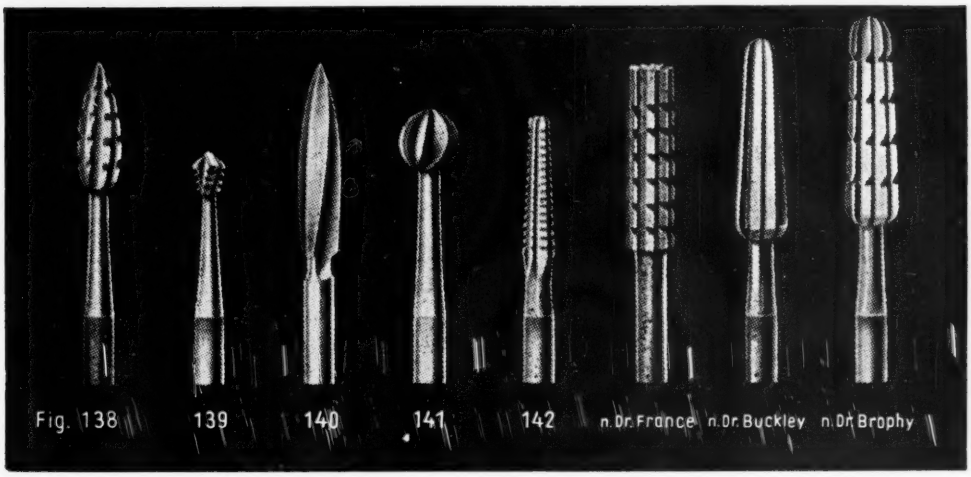

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